



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

UNIVERSITY OF VIRGINIA LIBRARY



X030348750

Digitized by Google



Ch. 1.
1918

REPORTS
OF THE
DEPARTMENT OF COMMERCE

1918

REPORT OF THE SECRETARY OF COMMERCE
AND
REPORTS OF BUREAUS



WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

Persons on a regular mailing list of the Department of Commerce should give prompt notice to the "Division of Publications, Department of Commerce, Washington, D. C.," of any change of address, stating specifically the form of address in which the publication has previously been received, as well as the new address. The Department should also be advised promptly when a publication is no longer desired.

Persons receiving publications which are not desired, or for which they have only temporary use, are requested to notify the Division of Publications. Franked mailing slips will be forwarded for their return.

CONTENTS.

REPORT OF THE SECRETARY OF COMMERCE.

	Page.
Travel allowance to Department employees.....	9
Representatives to meetings and conventions.....	9
The American-Canadian Fisheries Conference.....	9
Vessels of the Department's marine services.....	10
Indictments resulting from <i>Eastland</i> disaster.....	11
A permanent home for the Department of Commerce.....	11
Coast and Geodetic Survey.....	12
Bureau of Fisheries.....	13
Laboratory-aquarium.....	13
Bureau of Standards.....	13
Bureau of the Census.....	14
An archives building.....	15
Urgent needs of the Department.....	15
Appropriations and expenditures.....	16
Estimates for fiscal year ending June 30, 1920.....	29
Personnel.....	34
Printing and binding.....	39
Motor vehicles.....	43
Stock and shipping section.....	44
Department library.....	44
The Division of Supplies.....	45
Liberty Loans and War Savings Stamps.....	45
Purchase of Dutch Harbor, Alaska.....	46
Foundation for the Promotion of Industrial Peace.....	46
Abolition of the Official Register.....	46
Status of proposed legislation affecting the Department.....	46
Development of waterways.....	47
Work of the Solicitor's Office.....	47
Bureau of Foreign and Domestic Commerce.....	49
Balance of trade in favor of United States.....	50
Working policy.....	50
German trade.....	50
Independence of German chemicals.....	51
Defeating German commercial plots.....	52
Commercial attachés.....	52
Trade commissioners (traveling commercial agents).....	53
Investigations completed during the year.....	54
Investigations in progress.....	56
Statistical division.....	58
Latin American division.....	59
Far eastern division.....	60
Division of foreign tariffs.....	60

Bureau of Foreign and Domestic Commerce—Continued.	Page.
District offices	61
Editorial division	62
Statistical preparation for after-war trade	62
New plan to stimulate foreign trade	62
Recommendations	63
Bureau of Standards	67
Aeronautical research	68
Airplane power plants	70
Standardization of munitions master gauges	71
Optical instruments and light	72
Mine and railroad-track scales	75
Standardization of timepieces	76
Sound and acoustics	76
Electrical research and testing	77
Public utilities	78
Heat and temperature	80
Researches on metals and alloys	81
Testing of instruments and materials	83
Materials	84
Chemistry	85
Standardization of sugar technology	85
The Bureau's work for the soldier	86
The metric system	87
The importance of guaranteed standards in industry	87
Bureau of the Census	90
Current and completed work on statutory inquiries	90
Census of manufactures	90
Census of transportation by water	90
Census of shipbuilding	91
Census of electrical industries	91
Vital statistics	91
Financial statistics of cities	92
General statistics of cities	92
Financial statistics of States	93
Cotton and cotton seed	93
Stocks of leaf tobacco	93
Work pertaining to special classes of the population	94
Religious bodies	94
Official Register	94
War work	94
Work done by the Bureau for other governmental establishments	94
Special and miscellaneous lines of work	99
Marriage and divorce	99
Census of the Virgin Islands	99
United States life tables	100
Statistical directory of State institutions	100
Searching of census records to determine ages	100
Tabulation of data for disputed areas of Europe and Africa	100
Preparations for the Fourteenth Census	100
Mechanical equipment	101
Work in mechanical laboratory	101
Integrating counter	102
Office force	102
Office room and storage space	102

	Page.
Bureau of Fisheries	104
Propagation of food fishes	104
Record work in rescuing stranded food fishes	105
Increasing the consumption of fish	106
Development of aquatic sources of leather	107
A fishery-products laboratory	108
Administration of Alaskan fisheries	109
Alaska fur-seal industry	109
Census of Alaska seal herd	110
Revenue from Pribilof Islands products	111
A by-products plant for Pribilof Islands	112
Minor Alaskan fur-bearing animals	112
Personnel	113
Bureau of Lighthouses	114
Coast and Geodetic Survey	121
Field work	122
Hydrography	123
Geodesy	127
Need for survey vessels	127
Wire-drag launches	130
Enlistment of seamen	130
Additional hydrographic and geodetic engineers	132
Office needs	132
Instrument makers	135
Retirement for commissioned officers	135
Recent legislation	137
Steamboat-Inspection Service	139
Organization	139
Summary of activities and statistics	139
Part in the war with Germany	140
Examination of interned vessels	142
Important legislation	143
The spirit of the service	143
Bureau of Navigation	145
Shipping commissioners	147
Navigation receipts	147
Radio communication	147
Enforcement of the navigation laws	148
Tonnage admeasurement	149
Motor boats	149
Conclusion	150

REPORTS OF BUREAUS.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE	153
BUREAU OF STANDARDS	245
BUREAU OF THE CENSUS	441
BUREAU OF FISHERIES	469
BUREAU OF LIGHTHOUSES	561
COAST AND GEODETIC SURVEY	641
STEAMBOAT-INSPECTION SERVICE	767
BUREAU OF NAVIGATION	789
APPOINTMENT DIVISION	821
DIVISION OF PUBLICATIONS	835

INDEX	867
-------------	-----

REPORT
OF THE
SECRETARY OF COMMERCE

ANNUAL REPORT
OF THE
SECRETARY OF COMMERCE.

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, October 30, 1918.

To the PRESIDENT:

I have the honor to submit herewith my sixth annual report, covering the operations and condition of the Department during the fiscal year which ended June 30, 1918. It traces in a general way its operations to October 1, 1918.

Travel Allowance to Department Employees.

The unjust practice continues requiring some of our employees on small salaries who travel on Government business to pay, in large part, their own expenses. I renew my request that the law be changed to permit paying the necessary expenses of employees when required to travel on Government work.

Representatives to Meetings and Conventions.

When representatives from the Coast and Geodetic Survey, the Bureau of Fisheries, the Bureau of the Census, and other services are called upon to address conventions and meetings on the work conducted by them, they can not go unless they pay their own expenses or the expenses are paid by the organization they address. By special provision of law the Bureau of Standards may and does send representatives to meetings and conventions at public expense. This privilege should be extended to all other bureaus of the Department.

The American-Canadian Fisheries Conference.

The American-Canadian Fisheries Conference was appointed by the Governments of the United States and the Dominion of Canada for the purpose of considering and adjusting the differences between the two countries on the subject of fisheries. The con-

ference held its first session in Washington on January 16, 1918, and later conducted hearings in Boston; Gloucester; St. John, New Brunswick; Seattle, Wash.; Prince Rupert, British Columbia; Ketchikan, Alaska; Vancouver, British Columbia; New Westminster, British Columbia; and Ottawa, Canada. The final meeting of the conference was held at the Hotel Champlain, New York, on September 6. A report was then signed and transmitted to the Secretary of State of the United States and to the Governor in Council of the Dominion of Canada. The report is unanimous, and it is hoped will lead to a satisfactory and permanent solution of the problems considered.

Vessels of the Department's Marine Services.

The first-class seagoing lighthouse tender *Cedar* was placed in commission in Alaska in August, 1917, and has rendered satisfactory service.

Three of the older vessels of the Bureau of Fisheries, the *Grampus*, *Curlew*, and *Blue Wing*, having outlived their usefulness have been condemned and sold.

The small Fisheries steamer *Halcyon*, which was taken over by the Navy on May 14, 1917, made the fine record of 98.20 per cent on patrol service during the past severe winter, only two ships out of over a hundred making a higher record.

The Department had the following vessels in its marine service on October 1, 1918:

Service.	In operation.	Not in operation.	Being built.	Loaned to Navy Department.	Total.
Coast and Geodetic Survey	3	1	0	5	9
Bureau of Navigation	2	0	0	1	3
Bureau of Lighthouses:					
Tenders	3	0	0	47	50
Light vessels	63	0	2	3	68
Bureau of Fisheries	6	0	0	4	10
Total	77	1	2	60	140

This is exclusive of 4 vessels loaned to the Coast and Geodetic Survey by the Philippine Government and of 54 motor boats of all sizes operated by the Bureau of Fisheries.

On February 4, 1918, Cross Rip Light Vessel No. 6, Mass., was dragged from her station by ice and was lost with all the crew of six. On August 6, 1918, Diamond Shoal Light Vessel No. 71,

N. C., was sunk at her station by an enemy submarine. The crew were all saved.

No Trials Under Indictments Resulting from "Eastland" Disaster.

Last year I called attention to the fact that the courts had not acted under existing indictments in the matter of the licensed officers who were in charge of the steamer *Eastland* when she sank. No action has yet been taken. The attention of the proper authorities has been called to the delay of over three years.

A Permanent Home for the Department of Commerce.

This matter has been referred to repeatedly in my annual reports and the reports of the Public Buildings Commission, authorized to ascertain what public buildings are needed to provide permanent quarters for all Government activities in the District of Columbia.

The buildings occupied by the Department of Commerce and covered by the following statement are:

1. Commerce Building, Nineteenth Street and Pennsylvania Avenue NW.
2. Bureau of Fisheries Building, Sixth and B Streets SW.
3. Coast and Geodetic Survey Building, New Jersey Avenue near B Street SE., directly opposite the House of Representatives Office Building.

The buildings of the Bureau of Standards, located on Pierce Mill Road, near Connecticut Avenue, are excluded.

As the new Commerce Building contemplated by existing law (36 Stat., 698) should include the Coast and Geodetic Survey (releasing the property occupied by that service for other uses), and also the offices (not the laboratories) of the Bureau of Fisheries, it is treated first.

Five of the eight services of the Department and the divisions of the Secretary's Office are in the Commerce Building. With the normal growth of these services, which are the Bureaus of the Census, Foreign and Domestic Commerce, Navigation, Lighthouses, and the Steamboat-Inspection Service, the building will be too small before a new one can be constructed. It is now crowded.

The annual rent is \$65,500, which, though one of the lowest rentals per square foot in the District, represents, capitalized at 3 per cent, a valuation of \$2,183,333. It is a satisfactory structure.

My preference would be that the Department of Commerce should be housed in a building of commercial character.

Land for a new building was acquired for the then Department of Commerce *and Labor* under the act of May 30, 1908 (35 Stat., 545), and, by the act of June 25, 1910 (36 Stat., 698), the Secretary of the Treasury was directed to prepare designs and estimates for a fireproof building. On March 3, 1913, the plans for the proposed building for the Department of Commerce *and Labor* were approved by my predecessor. Since then three bureaus of the former Department have been transferred to the Department of Labor. One has gone to the Federal Trade Commission. Two of the present bureaus were omitted from the plans. The building, redesigned, should be made to accommodate the office, the lithographing establishment and its accessories, the drawing room and the instrument shop of the Coast and Geodetic Survey, and the administrative offices of the Bureau of Fisheries. If this were done, the property on Capitol Hill adjoining the Public Health Service, opposite the House Office Building and close to the Capitol itself, could be used for other purposes.

The lease of the present Commerce Building expired on August 31, 1918, and was renewed for 10 months, with privilege of renewal for a further period of 1 year.

The public interests, as they relate to this Department, will be advanced by redesigning the proposed Commerce Building as above suggested and by its construction at as early a date as possible.

Until such time as a permanent home is provided for the Department, authority is needed for the rental of an additional building containing approximately 10,000 square feet of office space. This is required by the increase of work. This additional space is particularly needed now to relieve congestion in the Bureau of Foreign and Domestic Commerce.

Coast and Geodetic Survey.

The buildings occupied by the Coast and Geodetic Survey are kept in a sanitary condition by persistent effort, but money is daily wasted in their occupancy. The buildings are five and six stories high, respectively, with 16 different levels in one and 11 different levels in the other. Anything more ill-suited for their use can hardly be imagined. On pages 218-220 of my report for 1917 I gave in detail the needs of an office building for the Coast and Geodetic Survey. These needs have been for a time relieved

in part by the allotment of a fund from your appropriation for national security and defense for constructing a plain, two-story, fireproof building to house and enlarge the instrument shop, the drawing room, and the carpenter shop, all of which are actively engaged in war work. This building is now under construction. It will include a fireproof vault for the original records of the service.

Bureau of Fisheries.

The structure occupied by the Bureau of Fisheries is unsuited to the growing work of the service and is a fire menace. By great care and by expenditure which is in no small part waste, the building is kept in fair condition. As an efficient working tool, however, it is hopeless. On July 2, 1918, you allotted \$125,000 from the fund for the national security and defense for a laboratory for the Bureau of Fisheries. This laboratory, which is to be located in Washington, will be equipped for experimentation in methods of preparing and preserving fish foods and other fishery products. The specifications for the building are prepared; it will be erected at the earliest possible date.

Laboratory-Aquarium.

I again call attention to the need of a laboratory-aquarium for the Bureau of Fisheries. (See pp. 12-14 of the Annual Report for 1917.) The mere mention of an aquarium may call up a picture of a popular resort with a certain incidental educational value. This would be an error. The proposed laboratory-aquarium would, first of all, be a laboratory in which the development of the food supply of the country would have the chief consideration. It would be in substance what an experiment station is to the Department of Agriculture, and would perform a similar function as regards food for the country.

Bureau of Standards.

Owing to the rapid expansion of the Bureau's work in metals upon our entrance in the war and the critical importance of metallurgy in its many military applications, an allotment was made by you on August 30, 1917, from the fund for national security and defense of \$250,000 for the erection of a laboratory for standardization of metals, appliances, and instruments for

military purposes. This building is in use. It provides suitable housing for other lines of military standardization.

The radio laboratory, for which a special appropriation of \$90,000 was provided by Congress, is completed and occupied by the Bureau and the representatives of the War and Navy Departments. It gives increased facilities for radio work, although, owing to the rapid expansion of this work since the war began, the building is not now large enough. It may be necessary to continue some radio work in another building.

The erection of an airplane-engine research laboratory for the Bureau of Standards will be commenced in the near future. The importance of the airplane program and the fact that the Bureau has long been continuously studying the underlying scientific principles involved in aircraft design and improvement for both Army and Navy made it necessary to provide suitably equipped housing for researches on airplane motors. This building will house four dynamometers, the refrigeration plant, two altitude laboratories, and the necessary equipment for running altitude tests of airplane engines. In this laboratory studies of airplane engines may be made under conditions which simulate high altitudes as to air pressure, air movement, and temperature, for altitudes near the surface and up to as high as 40,000 feet. These researches are enabling the Bureau to furnish the aviation services of both Army and Navy with new and reliable data for improving the efficiency of operation and control of airplane engines.

Special attention is invited to the recommendation respecting guaranteed standards in industry on page 87 of this report.

Bureau of the Census.

With each recurring census period and for about three years' time in each period the force of the Census Bureau is raised to about seven times its regular size. It is, of course, impossible to quarter any of this increase in the present Commerce Building. Were the new Commerce Building to be begun in the immediate future, a portion of it might be utilized to house some of this great additional force. Failing this, some of the special buildings occupied for war purposes may be used, provided they are not then required for war work and are in sufficiently good condition. The census period commences July 1, 1919; the buildings would have to be ready for use by or about that time. Failing one or another of these expedients, if the war should continue it may be

difficult to provide in Washington at any reasonable cost the necessary quarters for the census force.

At this time a measure (H. R. 11984) is pending providing for the Fourteenth Decennial Census—that of 1920. In preparing this measure a careful study was made of previous census legislation and experience. The pending bill is an advance over previous practice in every respect. It is essential that the measure be enacted by the present Congress, for the census period begins with July 1, 1919, and if authority of law is not provided prior to that time for taking the census of 1920, there will be added expense in doing the work, and the work itself will be delayed and its quality will be endangered.

An Archives Building.

The public buildings act of March 4, 1913, authorized the preparation of a design for an archives building, and the Secretary of the Treasury was authorized to select a site. The Public Buildings Commission has recommended squares 294 and 295 for such purposes.

In the recapitulation of space for the executive departments and independent establishments, 85,000 cubic feet are shown as needed by the Department of Commerce. It would not be sufficient, however, to have the Department's records given mere storage space. They are in constant use back to the beginnings of the Government, and the building should be so designed as to have them readily accessible. A small working force of librarians would be necessary.

Urgent Needs of the Department.

Among the urgent needs of the Department are:

1. Enlargement of the funds and the organization of the Bureau of Foreign and Domestic Commerce to make same adequate at home and abroad for the vital work that will be forced upon it at the war's close. This provision should immediately be made. More commercial attachés are needed abroad, and proper provision should be made for their clerks.
2. Two seagoing vessels and wire-drag launches for the Coast and Geodetic Survey and officers and crews for them.
3. Larger clerical force in the field service of the Steamboat-Inspection Service and in the office of the Coast and Geodetic

Survey, together with more draftsmen and computers at more adequate salaries in the latter service.

4. Provision, as above indicated, for the census of 1920 and arrangements for housing the increased force necessary at that time.

5. A building at the Bureau of Standards for a suitable power plant. The original installation has long since proved too small, and steps should be taken at once to provide a suitable and efficient heating and lighting plant.

6. A laboratory-aquarium for the Bureau of Fisheries.

7. A Government-owned commerce building to house all services except the Bureau of Standards and the laboratory-aquarium of the Bureau of Fisheries.

8. An assistant to the Secretary of Commerce to aid in the greatly increased volume of work.

Appropriations and Expenditures.

The itemized statement of the disbursements from the contingent fund of the Department of Commerce and the appropriation for "General expenses, Bureau of Standards," for the fiscal year ended June 30, 1918, required to be submitted to Congress by section 193 of the Revised Statutes of the United States; the itemized statement of expenditures under all appropriations for propagation of food fishes during the fiscal year ended June 30, 1918, required by the act of Congress approved March 3, 1887 (24 Stat., 523); and a statement showing travel on official business by officers and employees (other than special agents, inspectors, and employees who, in the discharge of their regular duties, are required to travel constantly) from Washington to points outside of the District of Columbia during the fiscal year ended June 30, 1918, as required by the act of Congress approved May 22, 1908 (35 Stat., 244), will be transmitted to Congress in the usual form.

The table following shows the total amounts of all appropriations for the various bureaus and services of the Department of Commerce for the fiscal year ended June 30, 1918.

Bureau.	Legislative act.	Sundry civil act.	Deficiency act.	Special act.	National security and defense.	Total.
Office of the Secretary.....	\$306,600.00		\$6,900.00		\$6,000,000.00	\$6,313,500.00
Bureau of Lighthouses.....	64,030.00	\$6,553,950.00	346,952.56			6,964,932.56
Bureau of the Census.....	1,383,460.00					1,383,460.00
Bureau of Foreign and Domestic Commerce.....	479,120.00		9,000.00		25,530.00	513,650.00
Bureau of Navigation.....	227,980.00			\$1,369.21		229,349.21
Bureau of Standards.....	739,900.00	65,000.00	498,087.38		1,395,000.00	2,712,987.38
Steamboat-Inspection Service.....	668,340.00		5,925.00			668,865.00
Bureau of Fisheries.....	1,190,560.00		123,000.00		75,000.00	1,388,560.00
Coast and Geodetic Survey.....	1,379,970.00		35,790.00		105,000.00	1,520,760.00
Total.....	3,883,430.00	9,129,480.00	1,019,654.94	1,369.21	7,600,530.00	21,624,464.15
Increase of compensation.....	440,871.15					440,871.15
Allotment for printing and binding.....		400,000.00				400,000.00
Grand total.....	4,323,301.15	9,529,480.00	1,019,654.94	1,369.21	7,600,530.00	22,544,355.30

The disbursements by the authorized disbursing officers of the Department of Commerce during the fiscal year ended June 30, 1918, arranged according to items of appropriation, are as follows:

By Disbursing Clerk, Department of Commerce.

OFFICE OF THE SECRETARY.

Salaries, Office of the Secretary of Commerce, 1917.....	\$7,248.77
Salaries, Office of the Secretary of Commerce, 1918.....	168,304.08
Contingent expenses, Department of Commerce, 1916.....	1,059.46
Contingent expenses, Department of Commerce, 1917.....	19,776.36
Contingent expenses, Department of Commerce, 1918.....	92,714.99
Rent, Department of Commerce, 1917.....	5,958.34
Rent, Department of Commerce, 1918.....	60,541.66
Total.....	355,603.66

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

Salaries, Bureau of Foreign and Domestic Commerce, 1917.....	5,185.65
Salaries, Bureau of Foreign and Domestic Commerce, 1918.....	136,532.64
Promoting Commerce, Department of Commerce, 1917.....	8,435.16
Promoting Commerce, Department of Commerce, 1918.....	52,680.17
Promoting Commerce, South and Central America, 1917.....	4,399.61
Promoting Commerce, South and Central America, 1918.....	29,431.62
Commercial attachés, Department of Commerce, 1917.....	2,051.64
Commercial attachés, Department of Commerce, 1918.....	4,437.25
National security and defense, Department of Commerce, export control.....	33,429.76
National security and defense, Department of Commerce, inland waterways.....	518.14
National security and defense, Department of Commerce, import and export statistics.....	8,550.28
Total.....	285,651.92

BUREAU OF STANDARDS.

Salaries, Bureau of Standards, 1917.....	\$12,424.10
Salaries, Bureau of Standards, 1918.....	304,454.55
Equipment, Bureau of Standards, 1916.....	474.09
Equipment, Bureau of Standards, 1917.....	14,163.48
Equipment, Bureau of Standards, 1918.....	47,108.08
General expenses, Bureau of Standards, 1916.....	24.33
General expenses, Bureau of Standards, 1917.....	8,247.31
General expenses, Bureau of Standards, 1918.....	25,318.08
Testing structural materials, Bureau of Standards, 1917.....	8,522.92
Testing structural materials, Bureau of Standards, 1918.....	132,133.12
Improvement and care of grounds, Bureau of Standards, 1917.....	2,645.68
Improvement and care of grounds, Bureau of Standards, 1918.....	4,752.00
Investigation of fire-resisting properties, Bureau of Standards, 1916....	15.38
Investigation of fire-resisting properties, Bureau of Standards, 1917...	6,555.63
Investigation of fire-resisting properties, Bureau of Standards, 1918...	22,349.34
Testing machines, Bureau of Standards, 1916.....	2,264.50
Testing machines, Bureau of Standards, 1917.....	4,441.97
Testing machines, Bureau of Standards, 1918.....	22,735.46
Testing railroad scales, etc., Bureau of Standards, 1916.....	6.46
Testing railroad scales, etc., Bureau of Standards, 1917.....	4,140.24
Testing railroad scales, etc., Bureau of Standards, 1918.....	28,631.97
Investigation of public-utility standards, Bureau of Standards, 1917..	1,960.06
Investigation of public-utility standards, Bureau of Standards, 1918..	45,935.49
High-potential investigations, Bureau of Standards, 1916.....	150.00
High-potential investigations, Bureau of Standards, 1917.....	1,052.82
High-potential investigations, Bureau of Standards, 1918.....	11,189.45
Investigation of railway materials, Bureau of Standards, 1917.....	2,071.79
Investigation of railway materials, Bureau of Standards, 1918.....	11,514.28
Refrigeration constants, Bureau of Standards, 1917.....	547.56
Testing miscellaneous materials, Bureau of Standards, 1917.....	2,477.90
Testing miscellaneous materials, Bureau of Standards, 1918.....	19,169.62
Radio research, Bureau of Standards, 1916.....	1.00
Radio research, Bureau of Standards, 1917.....	2,072.29
Radio research, Bureau of Standards, 1918.....	8,495.41
Equipping Chemical Laboratory building, Bureau of Standards, 1916-1917.....	19,519.52
Equipping Chemical Laboratory building, Bureau of Standards, 1917-1918.....	24,581.77
Investigation of clay products, Bureau of Standards, 1917.....	761.26
Investigation of clay products, Bureau of Standards, 1918.....	10,877.26
Determining physical constants, Bureau of Standards, 1917.....	1,394.95
Determining physical constants, Bureau of Standards, 1918.....	4,760.32
Color standardization, Bureau of Standards, 1917.....	2,245.15
Color standardization, Bureau of Standards, 1918.....	8,358.54
Radio Laboratory, Bureau of Standards.....	56,761.52
Chemical Laboratory, Bureau of Standards.....	2,553.80
Laboratory, Bureau of Standards.....	598.45
Workshop and storehouse, Bureau of Standards.....	17.00
Standardizing mechanical appliances, Bureau of Standards, 1917.....	6,716.05
Standardizing mechanical appliances, Bureau of Standards, 1918.....	9,553.99
Investigation of optical glass, 1918.....	8,993.62
Gauge standardization, Bureau of Standards, 1917-18.....	141,989.44

Military research, Bureau of Standards, 1917-18.....	\$361,754.21
Military research, Bureau of Standards, 1918-19.....	49,971.18
Investigation of mine scales and cars, Bureau of Standards, 1918-19..	/ 439.67
National security and defense, Bureau of Standards, production of optical glass.....	74,443.08
National security and defense, Bureau of Standards, new building...	232,552.39
National security and defense, Bureau of Standards, metallurgical work.....	40,579.65
National security and defense, Bureau of Standards, production of fabrics.....	326.75
National security and defense, Bureau of Standards, industrial laboratory.....	257,310.93
National security and defense, Bureau of Standards, Roberts by-product coke oven.....	1,929.15
National security and defense, Bureau of Standards, thermite investigation.....	7.00
Total.....	<u>2,077,043.01</u>

STEAMBOAT-INSPECTION SERVICE.

Salaries, Office of Supervising Inspector General, Steamboat-Inspection Service, 1917.....	685.03
Salaries, Office of Supervising Inspector General, Steamboat-Inspection Service, 1918.....	17,349.70
Salaries, Steamboat-Inspection Service, 1917.....	33,586.59
Salaries, Steamboat-Inspection Service, 1918.....	381,089.05
Clerk hire, Steamboat-Inspection Service, 1917.....	7,165.67
Clerk hire, Steamboat-Inspection Service, 1918.....	81,675.27
Contingent expenses, Steamboat-Inspection Service, 1916.....	81.23
Contingent expenses, Steamboat-Inspection Service, 1917.....	19,389.16
Contingent expenses, Steamboat-Inspection Service, 1918.....	78,537.49
Steamboat-Inspection Service, Tampa, Fla., 1918.....	3,942.69
Total.....	<u>623,501.88</u>

BUREAU OF NAVIGATION.

Salaries, Bureau of Navigation, 1917.....	1,485.30
Salaries, Bureau of Navigation, 1918.....	35,662.22
Clerk hire, shipping service, 1917.....	3,246.54
Clerk hire, shipping service, 1918.....	40,385.01
Salaries, shipping service, 1917.....	2,369.77
Salaries, shipping service, 1918.....	25,438.07
Contingent expenses, shipping service, 1917.....	856.44
Contingent expenses, shipping service, 1918.....	5,544.34
Preventing overcrowding of passenger vessels, 1917.....	2,037.31
Preventing overcrowding of passenger vessels, 1918.....	15,244.21
Enforcement of navigation laws, 1917.....	895.63
Enforcement of navigation laws, 1918.....	36,737.24
Enforcement of wireless-communication laws, 1916.....	1,258.50
Enforcement of wireless-communication laws, 1917.....	4,556.98
Enforcement of wireless-communication laws, 1918.....	34,612.32

Admeasurement of vessels, 1917.....	\$237. 31
Admeasurement of vessels, 1918.....	2, 091. 21
Total.....	<u>212, 658. 40</u>

BUREAU OF FISHERIES.

Salaries, Bureau of Fisheries, 1917.....	26, 820. 84
Salaries, Bureau of Fisheries, 1918.....	361, 831. 71
Miscellaneous expenses, Bureau of Fisheries, 1916.....	257. 74
Miscellaneous expenses, Bureau of Fisheries, 1917.....	53, 268. 24
Miscellaneous expenses, Bureau of Fisheries, 1918.....	413, 239. 12
Protecting seal and salmon fisheries of Alaska, 1916.....	214. 67
Protecting seal and salmon fisheries of Alaska, 1917.....	2, 132. 38
Protecting seal and salmon fisheries of Alaska, 1918.....	101, 297. 04
Marine biological station, Florida.....	20, 116. 75
Payment to Great Britain and Japan under Article XI of Fur-Seals Convention of 1911.....	20, 000. 00
Motor launches, Alaska fisheries service, 1917.....	499. 84
Developing aquatic sources of leather, 1917-18.....	1, 382. 82
Repairs to steamer <i>Fish Hawk</i>	21. 10
Investigating damages to fisheries.....	8, 219. 44
Buildings and improvements, fur-seal islands, Alaska.....	14, 906. 31
Launch for fish hatcheries, Mississippi River Valley.....	3, 355. 00
Fish hatcheries:	
Bozeman, Mont.....	2. 86
Cape Vincent, N. Y.....	35. 65
Clackamas, Oreg.....	613. 75
Cold Spring, Ga.....	52. 70
Edenton, N. C.....	7. 50
Puget Sound, Wash.....	6, 847. 33
Rhode Island.....	4, 000. 00
South Carolina.....	2, 451. 75
Utah.....	12, 824. 32
Wyoming.....	5, 265. 99
Vessels, fish hatchery, Boothbay Harbor, Me., 1915-16.....	4, 421. 70
National security and defense, food-fish supply.....	6, 970. 52
National security and defense, rescuing food fish.....	5, 280. 42
National security and defense, seal-oil plant.....	4, 357. 50
Total.....	<u>1, 080, 694. 99</u>

BUREAU OF THE CENSUS.

Salaries, Bureau of the Census, 1917.....	27, 243. 47
Salaries, Bureau of the Census, 1918.....	625, 516. 95
Collecting statistics, Bureau of the Census, 1917.....	34, 704. 81
Collecting statistics, Bureau of the Census, 1918.....	402, 561. 75
Tabulating machines, Bureau of the Census, 1917.....	5, 280. 04
Tabulating machines, Bureau of the Census, 1918.....	31, 913. 83
Total.....	<u>1, 127, 280. 85</u>

BUREAU OF LIGHTHOUSES.

Salaries, Bureau of Lighthouses, 1917.....	\$2, 632. 15
Salaries, Bureau of Lighthouses, 1918.....	57, 052. 80
Salaries, Lighthouse Service, 1917.....	281. 25
Salaries, Lighthouse Service, 1918.....	4, 543. 75
Salaries, lighthouse vessels, 1917.....	77. 50
Salaries, lighthouse vessels, 1918.....	75. 00
General expenses, Lighthouse Service, 1916.....	161. 24
General expenses, Lighthouse Service, 1917.....	33, 940. 14
General expenses, Lighthouse Service, 1918.....	88, 469. 74
Aids to navigation:	
Alaska.....	100. 94
Ashtabula Harbor, Ohio.....	10. 50
Conneaut Harbor, Ohio.....	3. 25
East River, N. Y.....	1. 00
Hudson River, N. Y.....	1. 39
Fighting Island Channel, Detroit River, Mich.....	. 30
Lorain Harbor, Ohio.....	5. 85
Pearl Harbor, Hawaii.....	. 25
Puget Sound, Wash.....	7. 60
St. Johns River, Fla.....	184. 43
Toledo Harbor, Ohio.....	3. 50
Cape Cod Canal Lights, Mass.....	3. 35
Cape St. Elias Light Station, Alaska.....	419. 99
Navassa Island Light Station, West Indies.....	48, 393. 95
Tender for first lighthouse district.....	2, 905. 94
Tender for third lighthouse district.....	72. 37
Tender for engineer, sixth lighthouse district.....	4. 86
Lighthouse tender for general service.....	57, 743. 80
Light vessels for general service.....	4, 794. 29
Light vessels for general lake service.....	80. 57
Chicago Harbor Light Station, Ill.....	6. 04
Galveston Jetty Light Station, Tex.....	73. 48
Kellelt Bluff Light Station, Wash.....	13. 20
Sand Hills Light Station, Mich.....	30. 60
South West Pass Light Vessel, Mississippi River, La.....	7. 91
Repairing and rebuilding aids to navigation, Gulf of Mexico.....	59. 97
Total.....	302, 162. 90

MISCELLANEOUS.

Increase of compensation.....	140, 792. 42
Grand total.....	6, 205, 330. 03

By disbursing officers of the Lighthouse Service.

Salaries, Lighthouse Service, 1917.....	\$3, 911. 33
Salaries, Lighthouse Service, 1918.....	357, 722. 18
Salaries, lighthouse vessels, 1917.....	43, 584. 08
Salaries, lighthouse vessels, 1918.....	1, 224, 475. 98
Salaries, keepers of lighthouses, 1917.....	28, 674. 78
Salaries, keepers of lighthouses, 1918.....	908, 810. 09
General expenses, Lighthouse Service, 1916.....	54, 994. 42

General expenses, Lighthouse Service, 1917.....	\$409, 079. 13
General expenses, Lighthouse Service, 1918.....	2, 323, 470. 64
Increase of compensation, Department of Commerce, 1918.....	217, 657. 72
Aids to navigation:	
Alaska.....	14, 584. 36
Ashland, Wis.....	56. 20
Ashtabula Harbor, Ohio.....	1, 070. 88
Atchafalaya Entrance Channel, La.....	5, 757. 92
Conneaut Harbor, Ohio.....	23, 950. 70
Coquille River, Oreg.....	63. 66
Delaware River, Pa. and Del.....	32, 824. 93
East River, N. Y.....	1, 325. 00
Fairport Harbor, Ohio.....	400. 00
Fighting Island, Detroit River, Mich.....	7, 437. 44
Florida Reefs, Fla.....	2, 300. 56
Hudson River, N. Y.....	1, 780. 65
Huron Harbor, Ohio.....	11. 84
Indian Harbor, Ill.....	28. 00
Keweenaw Waterway, Mich.....	14, 676. 32
Lorain Harbor, Ohio.....	891. 78
Manistique, Mich.....	22. 08
Pearl Harbor, Hawaii.....	4, 169. 62
Puget Sound, Wash.....	3, 029. 91
St. Johns River, Fla.....	10, 048. 39
Toledo Harbor, Ohio.....	13, 085. 31
Washington and Oregon.....	131. 25
Cape Cod Canal Lights, Mass.....	2, 176. 58
Detroit River Lights, Mich.....	5, 691. 82
Superior Pierhead Range Lights, Wis.....	1, 187. 22
Aransas Pass Light Station, Tex.....	5. 75
Cape St. Elias Light Station, Alaska.....	730. 78
Chicago Harbor Light Station, Ill.....	55, 037. 14
Galveston Jetty Light Station, Tex.....	51. 95
Kellett Bluff Light Station, Wash.....	1, 824. 00
Manitowoc Breakwater Light Station, Wis.....	964. 23
Navassa Island Light Station, West Indies.....	3, 464. 69
Sand Hills Light Station, Mich.....	23, 233. 07
Thimble Shoal Light Station, Va.....	3, 867. 64
White Shoal Light Station, Mich.....	780. 00
Woods Hole Light Station, Mass.....	14, 576. 82
Tender for first lighthouse district.....	1, 161. 40
Tender for engineer, sixth lighthouse district.....	2, 181. 67
Lighthouse tender for general service.....	1, 903. 40
Light vessels for general service.....	2, 175. 55
South West Pass Light Vessel, Mississippi River, La.....	75. 60
Staten Island lighthouse depot, N. Y.:	
Office.....	10. 04
Wharves.....	12. 54
Repairing and rebuilding aids to navigation, Gulf of Mexico.....	107, 653. 54
Repairing and rebuilding aids to navigation, Atlantic coast.....	15, 822. 05
Oil houses for light stations.....	12. 55
Lighting Norfolk Harbor, Va.....	1, 874. 08
Total.....	5, 956, 510. 26

By special disbursing agent, Coast and Geodetic Survey.

Salaries, Coast and Geodetic Survey, 1917	\$12,729.06
Salaries, Coast and Geodetic Survey, 1918	337,224.39
Party expenses, Coast and Geodetic Survey, 1916	7.71
Party expenses, Coast and Geodetic Survey, 1917	79,650.25
Party expenses, Coast and Geodetic Survey, 1918	322,083.69
Repairs of vessels, Coast and Geodetic Survey, 1917	5,164.80
Repairs of vessels, Coast and Geodetic Survey, 1918	19,217.17
General expenses, Coast and Geodetic Survey, 1916 .....	.35
General expenses, Coast and Geodetic Survey, 1917	4,596.37
General expenses, Coast and Geodetic Survey, 1918	64,515.12
Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1917	53,602.09
Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1918	162,078.24
Charts, Coast and Geodetic Survey, 1917-18	32,854.34
Outfitting Coast Survey steamer <i>Surveyor</i> , 1917	4,838.35
Two new vessels, Coast and Geodetic Survey	87,388.55
Increase of compensation, Department of Commerce, 1918	27,312.20
National security and defense, Department of Commerce, Coast and Geodetic Survey, new building	80.12
Additional employees, Coast and Geodetic Survey, 1918	3,762.72
Total	1,217,105.52

By special disbursing agents, Bureau of Fisheries.

Protecting seal and salmon fisheries of Alaska, 1918	\$1,998.05
Miscellaneous expenses, Bureau of Fisheries, 1918	15,717.73
Salaries, Bureau of Fisheries, 1918	1,198.31
Pay, officers and crews of vessels, Alaska fisheries service, 1918	21,587.59
Increase of compensation, Department of Commerce, 1918	1,401.87
Total	41,903.55

By the commercial agents investigating trade conditions abroad, Department of Commerce, acting as special disbursing agents.

Promoting commerce, Department of Commerce, 1917	\$6.35
Promoting commerce, Department of Commerce, 1918	59,420.13
Promoting commerce, South and Central America, 1917	650.00
Promoting commerce, South and Central America, 1918	54,624.05
Commercial attachés, Department of Commerce, 1917	3.56
Commercial attachés, Department of Commerce, 1918	86,153.88
National security and defense, export control, 1918	104.25
National security and defense, import and export statistics, 1918	1,463.47
Increase of compensation, Department of Commerce, 1918	921.54
Total	203,347.23

Warrants drawn on the Treasurer of the United States to satisfy accounts settled by the Auditor for the State and other departments, during the fiscal year ended June 30, 1918, classified according to items of appropriation:

Office of the Secretary:

Contingent expenses, Department of Commerce, 1916.....	\$62. 84
Contingent expenses, Department of Commerce, 1917.....	469. 20
Contingent expenses, Department of Commerce, 1918.....	43. 80
Total.....	<u>575. 84</u>

Bureau of Foreign and Domestic Commerce:

Promoting commerce, Department of Commerce, 1916.....	8. 26
Promoting commerce, Department of Commerce, 1917.....	486. 68
Promoting commerce, Department of Commerce, 1918.....	647. 70
Promoting commerce, South and Central America, 1917.....	228. 45
Promoting commerce, South and Central America, 1918.....	97. 92
Commercial attachés, 1916.....	56. 37
Commercial attachés, 1917.....	13. 39
Commercial attachés, 1918.....	41. 81
Total.....	<u>1, 580. 58</u>

Bureau of Standards:

General expenses, Bureau of Standards, 1917.....	331. 70
General expenses, Bureau of Standards, 1918.....	8. 40
Equipment, Bureau of Standards, 1917.....	115. 80
Improvement and care of grounds, 1918.....	11. 11
Testing structural materials, 1917.....	387. 28
Testing structural materials, 1918.....	288. 53
Testing machines, 1917.....	17. 44
Testing machines, 1918.....	19. 44
Investigation of fire-resisting properties, 1917.....	10. 84
Investigation of fire-resisting properties, 1918.....	16. 29
Investigation of public-utility standards, 1918.....	5. 00
Investigation of railway materials, 1917.....	63. 85
Determining physical constants, 1917.....	41. 67
Investigation of optical glass, 1918.....	8. 75
Gauge standardization, 1917-18.....	46. 03
Military research, 1917-18.....	529. 06
Military research, 1918-19.....	38. 85
National security and defense, production of optical glass.....	96. 78
National security and defense, industrial laboratory.....	49. 83
Certified claims—	
General expenses, Bureau of Standards, 1915.....	107. 38
Testing railroad scales, 1914.....	25. 00
Testing railroad scales, 1915.....	100. 08
Testing structural materials, 1915.....	15. 82
Investigation of railway materials, 1915.....	2. 00
Investigation of public-utility standards, 1915.....	227. 00
Equipment, Bureau of Standards, 1915.....	55. 67
Total.....	<u>2, 619. 60</u>

Bureau of Navigation:

Contingent expenses, Shipping Service, 1917.....	4. 15
Refunding penalties or charges erroneously exacted.....	1, 401. 79
Enforcement navigation laws, 1917.....	11. 01
Enforcement wireless-communication laws, 1916.....	60. 00

Bureau of Navigation—Continued.

Enforcement wireless-communication laws, 1917.....	\$9. 41
Enforcement wireless-communication laws, 1918.....	6. 58
Preventing overcrowding passenger vessels, 1917.....	2. 00
Total.....	<u>1, 494. 94</u>

Steamboat-Inspection Service:

Contingent expenses, Steamboat-Inspection Service, 1916.....	7. 41
Contingent expenses, Steamboat-Inspection Service, 1917.....	194. 36
Contingent expenses, Steamboat-Inspection Service, 1918.....	148. 91
Steamboat-Inspection Service, Tampa, Fla.....	1. 17
Certified Claims—Contingent expenses, Steamboat-Inspection Service, 1915.....	. 83
Total.....	<u>352. 68</u>

Bureau of Fisheries:

Miscellaneous expenses, Bureau of Fisheries, 1916.....	2. 54
Miscellaneous expenses, Bureau of Fisheries, 1917.....	13, 356. 20
Miscellaneous expenses, Bureau of Fisheries, 1918.....	18, 016. 49
Protecting seal and salmon fisheries of Alaska, 1917.....	1, 824. 47
Protecting seal and salmon fisheries of Alaska, 1918.....	631. 34
Marine Biological Station, Fla.....	2. 52
Steamer <i>Albatross</i> , repairs, 1917.....	9, 996. 75
Investigating damages to fisheries.....	83. 67
Repairs to steamer <i>Fish Hawk</i> , 1918.....	414. 90
Certified claims—	
Miscellaneous expenses, Bureau of Fisheries, 1914.....	8. 01
Miscellaneous expenses, Bureau of Fisheries, 1915.....	2. 26
Protecting seal and salmon fisheries of Alaska, 1915.....	2. 33
Total.....	<u>44, 341. 48</u>

Bureau of the Census:

Collecting statistics, Bureau of the Census, 1917.....	6. 49
Collecting statistics, Bureau of the Census, 1918.....	4, 354. 55
Tabulating machines, Bureau of the Census, 1917.....	2. 75
Relief of Alice V. Houghton.....	900. 00
Certified claims—Collecting statistics, Bureau of the Census, 1915.....	16. 35
Total.....	<u>5, 280. 14</u>

Coast and Geodetic Survey:

Party expenses, Coast and Geodetic Survey, 1916.....	37. 28
Party expenses, Coast and Geodetic Survey, 1917.....	14, 029. 58
Party expenses, Coast and Geodetic Survey, 1918.....	7, 966. 64
Repairs of vessels, Coast and Geodetic Survey, 1917.....	6, 625. 66
Repairs of vessels, Coast and Geodetic Survey, 1918.....	832. 57
General expenses, Coast and Geodetic Survey, 1917.....	63. 70
General expenses, Coast and Geodetic Survey, 1918.....	155. 00
Two new vessels, Coast and Geodetic Survey.....	14, 799. 36
Outfitting Coast Survey steamer <i>Surveyor</i> , 1917.....	1, 044. 53
Total.....	<u>45, 554. 32</u>

Bureau of Lighthouses:

Salaries, keepers of lighthouses, 1918.....	\$62. 00
Cape St. Elias Light Station, Alaska.....	1. 52
Light station, Sand Hills, Mich.....	417. 32
Light station, Navassa Island, West Indies.....	198. 96
Light vessel, South West Pass, Mississippi River, La.....	446. 10
Lights—	
Cape Cod Channel, Mass.....	4. 10
Detroit River, Mich.....	134. 17
Superior Pierhead Range, Wis.....	6. 60
Tender, engineer, sixth lighthouse district.....	149. 86
Lighthouse tender, general service.....	354. 90
Aids to navigation—	
Alaska.....	2, 563. 06
Delaware River, Pa. and Del.....	337. 50
Keweenaw Waterway, Mich.....	903. 37
Puget Sound, Wash.....	473. 28
St. Johns River, Fla.....	1, 352. 01
Fighting Island Channel, Detroit River, Mich.....	322. 21
Pearl Harbor, Hawaii.....	118. 91
Washington and Oregon.....	60. 86
General expenses, Lighthouse Service, 1916.....	4, 747. 39
General expenses, Lighthouse Service, 1917.....	31, 284. 86
General expenses, Lighthouse Service, 1918.....	45, 105. 66
Salaries, lighthouse vessels, 1916.....	2. 33
Salaries, lighthouse vessels, 1917.....	1, 000. 66
Salaries, lighthouse vessels, 1918.....	4, 490. 83
Salaries, Lighthouse Service, 1917.....	24. 34
Light vessels for general service.....	9. 44
Claims for damages by collision with lighthouse vessels.....	598. 58
Repairing and rebuilding aids to navigation, Gulf of Mexico.....	1, 521. 45
Repairing and rebuilding aids to navigation, Atlantic coast.....	5, 972. 84
Radio installations on lighthouse tenders.....	23. 12
Certified claims—	
General expenses, Lighthouse Service, 1912.....	166. 66
General expenses, Lighthouse Service, 1913.....	18. 59
General expenses, Lighthouse Service, 1914.....	22. 36
General expenses, Lighthouse Service, 1915.....	156. 23
General expenses, Lighthouse Service, 1916.....	1. 20
Salaries, lighthouse vessels, 1912.....	19. 50
Expenses of buoyage, 1910.....	4, 616. 53
Expenses of light vessels, 1910.....	21, 749. 53
Total.....	129, 438. 83
Grand total.....	231, 238. 41

The following statement shows the expenditures during the fiscal year ended June 30, 1918, on account of all appropriations under the control of the Department, giving the total amounts disbursed by the various disbursing officers of the Department, and miscellaneous receipts for the same period:

EXPENDITURES.

By the Disbursing Clerk, Department of Commerce, on account of salaries and expenses of the Office of the Secretary of Commerce, the Bureaus of Foreign and Domestic Commerce, Navigation, Standards, Fisheries, Census, and Lighthouses, the Office of the Supervising Inspector General, Steamboat-Inspection Service, salaries and expenses of the Steamboat-Inspection Service at large, and public works of the Lighthouse and Fisheries Services (shown in detail in the first of the foregoing tables of disbursements).....	\$6,205,330.03
By authorized disbursing agents of the Lighthouse Service.....	5,956,510.26
By special disbursing agent, Coast and Geodetic Survey, on account of salaries and expenses of the Coast and Geodetic Survey.....	1,217,105.52
By special disbursing agents, Bureau of Fisheries.....	41,903.55
By the commercial agents of the Department investigating trade conditions abroad as special disbursing agents.....	203,347.23
By warrants drawn on the Treasurer of the United States to satisfy accounts settled by the Auditor for the State and other Departments.....	231,238.41
Printing and binding.....	394,952.24
Total.....	<u>14,250,387.24</u>

MISCELLANEOUS RECEIPTS.

Coast and Geodetic Survey: Sale of charts, publications, old property, etc.....	20,088.18
Bureau of Census: Sale of publications, etc.....	310.00
Bureau of Fisheries:	
Sale of 3,264 sealskins.....	69,946.48
Sale of fox and other skins.....	34,356.88
Sale of old property, etc.....	11,136.18
Bureau of Navigation:	
Tonnage tax.....	1,171,418.36
Navigation fees.....	146,508.02
Navigation fines.....	31,837.68
From deceased passengers.....	260.00
Annual yacht tax.....	1,468.60
Bureau of Standards: Sale of Government property, etc.....	2,682.84
Steamboat-Inspection Service: Sale of Government property, etc.....	13.00
Bureau of Lighthouses: Sale of Government property, rentals, etc....	22,719.32
Office of the Secretary: Sale of Government property, etc.....	384.09
Total.....	<u>1,513,129.63</u>

The following unexpended balances of appropriations were turned into the surplus fund June 30, 1918, in accordance with the act of June 20, 1874 (18 Stat., 110-111):

Office of the Secretary:	
Salaries, Office of the Secretary of Commerce, 1916.....	\$1,709.09
Rent, Department of Commerce, 1916.....	.02
Contingent expenses, Department of Commerce, 1915.....	5.00
Contingent expenses, Department of Commerce, 1916.....	48.18
Bureau of the Census:	
Salaries, Bureau of the Census, 1916.....	10,234.65
Collecting statistics, Bureau of the Census, 1915-16.....	112.21

Bureau of the Census—Continued.

Collecting statistics, Bureau of the Census, 1916.....	\$351. 57
Tabulating machines, Bureau of the Census, 1916.....	420. 02

Bureau of Foreign and Domestic Commerce:

Salaries, Bureau of Foreign and Domestic Commerce, 1916.....	571. 99
Commercial attachés, Department of Commerce, 1915.....	38. 89
Commercial attachés, Department of Commerce, 1916.....	691. 56
Promoting Commerce, Department of Commerce, 1916.....	33. 66
Promoting Commerce, South and Central America, 1915.....	39. 52
Promoting Commerce, South and Central America, 1916.....	2, 584. 37
Investigating cost of production, Department of Commerce, 1916..	249. 66

Steamboat-Inspection Service:

Salaries, Office of Supervising Inspector General, Steamboat-Inspection Service, 1916.....	124. 99
Salaries, Steamboat-Inspection Service, 1916.....	3, 431. 58
Clerk hire, steamboat-Inspection Service, 1916.....	12. 92
Contingent expenses, Steamboat-Inspection Service, 1916.....	76. 22

Bureau of Navigation:

Salaries, Bureau of Navigation, 1916.....	115. 58
Salaries, Shipping Service, 1916.....	560. 17
Clerk hire, Shipping Service, 1916.....	527. 38
Contingent expenses, Shipping Service, 1916.....	137. 52
Admeasurement of vessels, 1916.....	19. 46
Preventing overcrowding of passenger vessels, 1916.....	23. 85
Enforcement of navigation laws, 1916.....	137. 00
Enforcement of wireless-communication laws, 1916.....	322. 96

Bureau of Standards:

Salaries, Bureau of Standards, 1916.....	15, 700. 16
Equipment, Bureau of Standards, 1916.....	1, 833. 35
General expenses, Bureau of Standards, 1916.....	319. 66
Improvement and care of grounds, Bureau of Standards, 1916....	98. 89
Current meter testing tanks, 1916.....	1. 66
Heating system, north laboratory, 1916.....	479. 46
Investigation of fire-resisting properties, 1916.....	119. 88
High-potential investigation, 1916.....	50. 08
Investigation of public-utility standards, 1916.....	243. 71
Investigation of railway materials, Bureau of Standards, 1916....	572. 85
Radio research, 1916.....	167. 25
Refrigeration constants, 1916.....	76. 77
Testing machines, 1916.....	100. 93
Testing miscellaneous materials, 1916.....	. 04
Testing railroad scales, etc., 1916.....	12, 264. 76
Testing structural materials, 1916.....	517. 07

Coast and Geodetic Survey:

Salaries, Coast and Geodetic Survey, 1916.....	2, 236. 82
Party expenses, Coast and Geodetic Survey, 1915-16.....	685. 82
Party expenses, Coast and Geodetic Survey, 1916.....	2, 385. 66
General expenses, Coast and Geodetic Survey, 1916.....	220. 35
Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1916.....	10, 001. 46
Repairs of vessels, Coast and Geodetic Survey, 1916.....	361. 14
Repairs to Coast Survey steamer <i>Explorer</i> , 1916.....	1, 664. 80

Bureau of Lighthouses:

Salaries, Bureau of Lighthouses, 1916.....	\$589. 85
General expenses, Lighthouse Service, 1914.....	300. 00
General expenses, Lighthouse Service, 1916.....	6, 768. 92
Salaries, keepers of lighthouses, 1916.....	17, 917. 97
Salaries, lighthouse vessels, 1916.....	29, 060. 51
Salaries, Lighthouse Service, 1916.....	3, 394. 96
Aids to navigation, Manistique, Mich.....	. 22

Bureau of Fisheries:

Salaries, Bureau of Fisheries, 1916.....	9, 985. 53
Miscellaneous expenses, Bureau of Fisheries, 1915-16.....	598. 99
Miscellaneous expenses, Bureau of Fisheries, 1916.....	2, 123. 63
Pay, officers and crew of vessel, Alaska fisheries service, 1916....	365. 68
Protecting seal and salmon fisheries of Alaska, 1916.....	109. 87
Launch for fish hatcheries, Mississippi River Valley.....	4, 609. 57
Vessels, fish hatchery, Boothbay Harbor, Me., 1915-16.....	247. 49
Cold-storage plant, fur-seal islands, Alaska, 1915-16.....	253. 73

Total.....	149, 009. 51
------------	--------------

Estimates for the Fiscal Year Ending June 30, 1920.

The estimates for the fiscal year 1920, aggregating \$39,727,740, exceed the estimates for the fiscal year 1919, amounting to \$18,156,065, by \$21,571,675 and exceed the appropriations for 1919, amounting to \$15,227,779.56, by the sum of \$24,499,960.44.

The principal increases are shown in the estimates for the Bureau of the Census, which under the law must take up the preparation for and the taking of the Fourteenth Decennial Census, the work in connection with which will extend over a period of three years, beginning with July 1, 1919, and ending on June 30, 1922.

It is impossible to apportion with any degree of accuracy the cost of the work among the three fiscal years which will constitute the census period. The records of the Thirteenth Census provide no reliable basis on which to make such an apportionment. That census was taken as of April 15, 1910, and at the close of the first fiscal year not all the enumerators had been paid. It is proposed to take the Fourteenth Census as of January 1, 1920, and at the close of the fiscal year all the enumerators will have been paid and the work of compilation will be approximately three and a half months further advanced than was the corresponding work of the Thirteenth Census on June 30, 1910. Obviously, however, the greatest part of the total expense of the census—perhaps as much as \$15,000,000—will fall within the first fiscal year, for during that year the great bulk of the payments for field work will have been made.

For the Lighthouse Service the increase approximates \$4,000,000, the principal items for which have been authorized by the Congress.

For the Bureau of Foreign and Domestic Commerce an increase of \$698,380 is estimated for the extension of the postwar trade.

For the Steamboat-Inspection Service the increase is \$342,230 and is to provide for additional inspectors, clerks, and contingent expenses necessary to carry on the work of the Bureau incident to the shipping program of the Government.

For the Bureau of Standards the increase is \$263,100, due to largely increased activities of the Bureau, and especially in connection with the war work of the Government.

For the Coast and Geodetic Survey the increase is \$654,885.44, principally for new vessels required for that service.

The table following gives the details of all items of estimates for the fiscal year 1920 as compared with items of appropriations for the fiscal year 1919:

COMPARISON BETWEEN THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1920 AND APPROPRIATIONS FOR THE FISCAL YEAR 1919.

	Estimates, 1920.	Appropriations, 1919.	Increase.	Decrease.
OFFICE OF THE SECRETARY.				
Salaries.....	\$206,900.00	\$189,040.00	\$17,860.00	
Contingent expenses.....	60,000.00	70,000.00		\$10,000.00
Rent.....	79,000.00	66,500.00	12,500.00	
Rent of storage space.....	2,000.00	2,000.00		
Total.....	347,900.00	327,540.00	30,360.00	10,000.00
Net increase.....			20,360.00	
LIGHTHOUSE SERVICE.				
Salaries, Bureau of Lighthouses.....	65,430.00	65,430.00		
General expenses.....	4,000,000.00	3,500,000.00	500,000.00	
Salaries of keepers.....	1,321,600.00	940,000.00	381,600.00	
Salaries, light vessels.....	1,880,000.00	1,265,000.00	615,000.00	
Salaries, Lighthouse Service.....	433,000.00	380,000.00	53,000.00	
Retired pay, Lighthouse Service.....	50,000.00		50,000.00	
Public works:				
Tenders and light vessels.....	760,000.00		760,000.00	
Hawaiian Islands, lighthouse depot.....	120,000.00		120,000.00	
Light-keepers' dwellings.....	75,000.00		75,000.00	
Fifth lighthouse district, depot Portsmouth, Va.....	275,000.00		275,000.00	
St. Marys River, Mich., aids to navigation.....	80,000.00		80,000.00	
Staten Island, depot machine shop.....	45,000.00		45,000.00	
Virgin Islands, aids to navigation.....	50,000.00		50,000.00	
Staten Island, wharves.....	65,000.00		65,000.00	
Potomac River, aids to navigation.....	95,000.00		95,000.00	
Eighth lighthouse district, depot, New Orleans.....	88,500.00		88,500.00	

COMPARISON BETWEEN THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1920 AND APPROPRIATIONS FOR THE FISCAL YEAR 1919—Continued.

	Estimates, 1920.	Appropriations, 1919.	Increase.	Decrease.
LIGHTHOUSE SERVICE—continued.				
Public works—Continued.				
Third lighthouse district, riprap protections.....	\$284,000.00		\$284,000.00	
Charleston, S. C., depot.....	115,000.00		115,000.00	
Seventh lighthouse district, site, etc., depot....	200,000.00		200,000.00	
Alaska, aids to navigation.....	75,000.00		75,000.00	
Ludington, Mich., aids to navigation.....	50,000.00		50,000.00	
Tampa Bay, Fla., aids to navigation.....	17,500.00		17,500.00	
Delaware Bay Entrance, aids to navigation.....	148,500.00		148,500.00	
Goose Island Flats, fog signal.....	140,000.00		140,000.00	
California and Nevada, aids to navigation.....	37,775.00		37,775.00	
Goat Island, Cal., dwellings.....	16,500.00		16,500.00	
Quantanamo Bay, aids to navigation.....		\$14,000.00		\$14,000.00
Second lighthouse district, Boston depot.....		85,000.00		85,000.00
Detroit, depot.....		53,000.00		53,000.00
Sand Island Light Station.....		37,000.00		37,000.00
Spectacle Reef Light Station.....		28,000.00		28,000.00
Ambrose Channel, N. Y., buoys.....		26,000.00		26,000.00
Fifth lighthouse district, gas buoys.....		65,000.00		65,000.00
Sixteenth lighthouse district, depot.....		90,000.00		90,000.00
National security and defense (depot, third light-house district).....		175,000.00		175,000.00
National security and defense (aids to navigation, Caribbean Sea).....		100,000.00		100,000.00
Total.....	10,487,805.00	6,823,430.00	4,337,375.00	673,000.00
Net increase.....			3,664,375.00	
BUREAU OF THE CENSUS.				
For salaries and necessary expenses of every kind and character in connection with taking and publishing the Fourteenth Census, and covering three years, July 1, 1919, to June 30, 1922.....	20,500,000.00		20,500,000.00	
Salaries.....		739,240.00		739,240.00
Collecting statistics.....		490,000.00		490,000.00
Tabulating machines.....		60,000.00		60,000.00
Punching machines.....		60,000.00		60,000.00
National security and defense special statistics.....		175,000.00		175,000.00
Total.....	20,500,000.00	1,524,240.00	20,500,000.00	1,524,240.00
Net increase.....			18,975,760.00	
BUREAU OF FOREIGN AND DOMESTIC COMMERCE.				
Salaries.....	314,500.00	154,120.00	160,380.00	
Promoting commerce.....	435,000.00	125,000.00	310,000.00	
Promoting commerce, South and Central America....	125,000.00	100,000.00	25,000.00	
Promoting commerce, Far East.....	137,000.00	50,000.00	87,000.00	
Commercial attachés.....	272,000.00	125,000.00	147,000.00	
Developing trade by motion pictures.....	69,000.00		69,000.00	
National security and defense, foreign-trade statistics.....		100,000.00		100,000.00
Total.....	1,352,500.00	654,120.00	798,380.00	100,000.00
Net increase.....			698,380.00	

* Part for Bureau of Foreign and Domestic Commerce.

COMPARISON BETWEEN THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1920 AND APPROPRIATIONS FOR THE FISCAL YEAR 1919—Continued.

	Estimates, 1920.	Appropriations, 1919.	Increase.	Decrease.
STEAMBOAT-INSPECTION SERVICE.				
Salaries, Office of Supervising Inspector General.....	\$23,940.00	\$19,440.00	\$4,500.00	
Salaries, Steamboat-Inspection Service.....	729,150.00	463,400.00	265,750.00	
Clerk hire.....	127,000.00	100,000.00	27,000.00	
Contingent expenses.....	175,000.00	150,000.00	25,000.00	
Total.....	1,055,090.00	712,740.00	342,350.00	
BUREAU OF NAVIGATION.				
Salaries, Bureau of Navigation.....	39,730.00	38,130.00	1,600.00	
Salaries, Shipping Service.....	30,100.00	30,100.00		
Clerk hire, Shipping Service.....	11,300.00	47,700.00	3,600.00	
Contingent expenses.....	8,365.00	8,365.00		
Admeasurement of vessels.....	3,500.00	3,500.00		
Instruments for counting.....	250.00	250.00		
Enforcement of navigation laws.....	26,000.00	26,000.00		
Overcrowding of vessels.....	18,000.00	18,000.00		
Enforcement wireless laws.....	45,000.00	45,000.00		
National security and defense (new vessel).....		40,000.00		\$40,000.00
Total.....	222,245.00	257,045.00	5,200.00	40,000.00
Net decrease.....				34,800.00
BUREAU OF STANDARDS.				
Salaries.....	533,760.00	432,360.00	101,400.00	
Equipment.....	100,000.00	75,000.00	25,000.00	
Repairs, etc.....	10,000.00	6,000.00	4,000.00	
General expenses.....	60,000.00	50,000.00	10,000.00	
Grounds.....	10,000.00	7,500.00	2,500.00	
High potential.....	25,000.00	15,000.00	10,000.00	
Structural materials.....	175,000.00	125,000.00	50,000.00	
Testing machines.....	35,000.00	30,000.00	5,000.00	
Fire-resisting properties.....	60,000.00	25,000.00	35,000.00	
Public utilities.....	200,000.00	50,000.00	150,000.00	
Railway materials.....	20,000.00	15,000.00	5,000.00	
Miscellaneous materials.....	35,000.00	30,000.00	5,000.00	
Radio communication.....	40,000.00	20,000.00	20,000.00	
Color standardization.....	15,000.00	10,000.00	5,000.00	
Clay products.....	30,000.00	20,000.00	10,000.00	
Physical constants.....	15,000.00	5,000.00	10,000.00	
Mechanical appliances.....	25,000.00	10,000.00	15,000.00	
Investigation optical glass.....	25,000.00	20,000.00	5,000.00	
Standard materials.....	10,000.00	4,000.00	6,000.00	
Paper, leather, rubber, etc.....	25,000.00	10,000.00	15,000.00	
Sugar technology.....	30,000.00	20,000.00	10,000.00	
Gauge standardization.....	150,000.00	150,000.00		
Storage batteries.....		20,000.00		20,000.00
Mine scales, etc.....	55,000.00		55,000.00	
Electrodeposition metals.....	10,000.00		10,000.00	
Metallurgical research.....	50,000.00		50,000.00	
Chemical reagents.....	15,000.00		15,000.00	
Illumination investigation.....	10,000.00		10,000.00	
Radioactivity.....	10,000.00		10,000.00	

COMPARISON BETWEEN THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1920 AND APPROPRIATIONS FOR THE FISCAL YEAR 1919—Continued.

	Estimates, 1920.	Appropriations, 1919.	Increase.	Decrease.
BUREAU OF STANDARDS—continued.				
Magnetic analysis.....	\$10,000.00		\$10,000.00	
Insulating materials.....	10,000.00		10,000.00	
Sea-water concrete.....	15,000.00		15,000.00	
Industrial pyrometry.....	15,000.00		15,000.00	
Industrial safety standards.....	25,000.00		25,000.00	
Alloy steels investigation.....	25,000.00		25,000.00	
Equipping laboratory.....	100,000.00		100,000.00	
Sound investigation.....	15,000.00		15,000.00	
Testing large scales.....	40,000.00	\$40,000.00		
Test-car depot.....	40,000.00		40,000.00	
Power-plant building.....	25,000.00		25,000.00	
Military research ^a		250,000.00		\$250,000.00
Investigating mine scales and cars ^a		15,000.00		15,000.00
Investigating public-utility companies ^a		50,000.00		50,000.00
National security and defense, thermite investigation.....		4,300.00		4,300.00
National security and defense, aircraft production.....		60,000.00		60,000.00
National security and defense, industrial laboratory.....		31,500.00		31,500.00
National security and defense, industrial laboratory.....		235,000.00		235,000.00
Total.....	2,098,760.00	1,835,660.00	928,900.00	665,800.00
Net increase.....			263,100.00	
BUREAU OF FISHERIES.				
Salaries, Bureau of Fisheries.....	133,440.00	109,120.00	24,320.00	
Salaries, field service.....	336,080.00	328,340.00	7,740.00	
Cabin boy, Fish Hawk.....		480.00		480.00
Miscellaneous expenses.....	710,500.00	665,500.00	45,000.00	
Fish hatcheries:				
Cape Vincent, N. Y.....	10,000.00		10,000.00	
Duluth, Minn.....	4,500.00		4,500.00	
Wytheville, Va.....	10,000.00		10,000.00	
Yes Bay, Alaska.....	25,000.00		25,000.00	
Lobster rearing plant.....	10,000.00		10,000.00	
Fur-seal islands, Alaska.....	15,000.00		15,000.00	
Hatchery, Berkshire, Mass.....		2,500.00		2,500.00
St. Johnsbury (Vt.) Station.....		5,000.00		5,000.00
Fur-seal islands power lighter.....		20,000.00		20,000.00
National security and defense, fishery foods, etc.....		150,000.00		150,000.00
Total.....	1,254,520.00	1,280,940.00	151,560.00	177,980.00
Net decrease.....				26,420.00
COAST AND GEODETIC SURVEY.				
Party expenses.....	382,600.00	382,600.00		
Repairs of vessels.....	31,000.00	36,000.00		5,000.00
Pay, etc., officers and men.....	185,000.00	225,000.00		40,000.00
Salaries.....	607,820.00	477,360.00	130,460.00	
General expenses.....	90,000.00	80,000.00	10,000.00	
New vessels.....	770,500.00	50,000.00	720,500.00	

^a Deficiency act approved Mar. 28, 1922.

COMPARISON BETWEEN THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1920 AND APPROPRIATIONS FOR THE FISCAL YEAR 1919—Continued.

	Estimates, 1920.	Appropriations, 1919.	Increase.	Decrease.
COAST AND GEODETIC SURVEY—continued.				
Two motor-driven lathes.....		\$1,500.00		\$1,500.00
Taku, vessel to replace.....		50,000.00		50,000.00
Four or more motor launches.....		62,500.00		62,500.00
National security and defense, map-work building.....		3,854.56		3,854.56
National security and defense, printing charts.....		14,000.00		14,000.00
National security and defense, new building.....		29,250.00		29,250.00
Total.....	\$2,066,920.00	1,412,064.56	\$860,960.00	206,104.56
Net increase.....			654,855.44	
Printing and binding.....	342,000.00	400,000.00		58,000.00
Grand total.....	39,727,740.00	15,227,779.56	27,955,085.00	3,455,124.56
Net increase.....			24,499,960.44	

Personnel.

The accompanying table shows, by bureaus, the number of permanent positions in the Department on July 1, 1918, and the increase or decrease as compared with July 1, 1917. The figures do not include temporary appointments, nor the following appointments or employments not made by the head of the Department: Persons engaged in rodding, chaining, recording, heliotroping, etc., in field operations of the Bureau of Fisheries; mechanics, skilled tradesmen, and laborers in the Lighthouse Service employed under authority of Schedule A, Subdivision I, section 12, of the civil-service rules. Enlisted men on vessels of the Coast and Geodetic Survey in the Philippine Islands and officers and men of the Navy Department employed on vessels of the Bureau of Fisheries are also excluded. The total of these excluded miscellaneous employments and enlistments is approximately 4,444 as compared with 4,524 for the fiscal year 1917. At the close of the fiscal year 1918 there were 832 employees in the service of the Department serving under temporary appointment or employment.

The total number of permanent positions referred to in the accompanying table, together with the employments and enlistments just mentioned, on July 1, 1918, was approximately 11,051 as compared with 10,079 on July 1, 1917. This includes 1,372 positions the incumbents of which have been temporarily transferred to the War or Navy Departments. The total number of employees of all kinds actually in the service of this Department on July 1, 1918, was approximately 9,679.

Bureau.	Statu- tory.	Nonstatu- tory.	Total.	In District of Colum- bia.	Outside District of Columbia.	Increase (+) or decrease (-).
Office of the Secretary.....	178	.....	178	178	.....	+ 6
Bureau of the Census.....	609	768	1,397	673	684	+150
Bureau of Foreign and Domestic Commerce.....	113	107	220	6171	49	- 13
Bureau of Standards.....	348	719	1,067	924	147	+543
Bureau of Fisheries.....	405	15	420	82	338	- 32
Bureau of Lighthouses.....	56	5,767	5,823	43	5,780	+120
Coast and Geodetic Survey.....	313	227	540	6,341	199	-250
Bureau of Navigation.....	44	189	233	35	198	+ 66
Steamboat-Inspection Service.....	264	83	347	13	334	+ 26
Total (permanent).....	2,324	7,895	10,219	2,490	7,729	+606
Temporary appointments and em- ployments.....	.....	832	832	.....	832	.....
Grand total (including tem- porary employments and enlist- ments).....	.....	8,727	11,051	.....	8,561	.....

^a Employees engaged in work in the field for a part of each year, with headquarters in Washington, are treated as within the District of Columbia.

^b Includes the following positions, appointment to which is not made by the head of the Department: 409 (259 classified competitive and 150 classified excepted) mechanics, skilled tradesmen, and laborers employed in field construction work in the Lighthouse Service and work of a similar character at the general lighthouse depot at Tompkinsville, N. Y., 1,523 laborers in charge of post lights, and 1,376 members of crews of vessels.

^c Includes 2 stenographers and typewriters authorized by law, and not to be employed exceeding 6 months.

The following tables give a summary of changes in the personnel of the Department for the fiscal year ended June 30, 1918:

APPOINTMENTS, PROMOTIONS, AND REDUCTIONS.

Bureau.	Appointments. ^a						Promo- tions.	Reduc- tion
	Permanent.				Tempo- rary.	Grand total.		
	Com- peti- tive.	Ex- cepted.	Un- classi- fied.	Total.				
Office of the Secretary.....	59	.....	8	67	77	144	45	1
Foreign and Domestic Commerce.....	158	76	.....	234	60	294	153	8
Census.....	88	.....	233	321	212	533	130	1
Standards.....	433	10	70	513	1,070	1,583	586	8
Fisheries.....	37	3	8	48	103	151	43	.....
Lighthouses.....	384	70	.....	454	385	839	887	^b 122
Coast and Geodetic Survey.....	47	.....	6	53	175	228	212	4
Navigation.....	46	25	5	76	77	153	84	.....
Steamboat-Inspection Service.....	57	1	.....	58	47	105	49	.....
Total.....	1,309	185	330	1,824	2,106	3,930	^c 2,187	144

^a Includes appointments of the following character: Presidential, by selection from civil-service certificates under Executive order, to excepted positions, by reinstatement, and by reason of transfer within the Department or from other departments or independent establishments.

^b Mainly voluntary reductions accepted by employees to secure more desirable conditions of living.

^c Includes 466 temporary increases in the personnel of the Lighthouse Service.

SEPARATIONS AND MISCELLANEOUS CHANGES.

Bureau.	Separations. ^a						Miscellaneous changes. ^b
	From permanent positions.				From temporary positions.	Grand total.	
	Competitive.	Ex-cepted.	Un-classified.	Total.			
Office of the Secretary.....	63	2	10	75	38	113	10
Foreign and Domestic Commerce.....	91	18	.....	109	17	126	34
Census.....	95	.....	148	243	212	455	26
Standards.....	241	17	30	288	469	757	21
Fisheries.....	102	2	14	118	44	162	17
Lighthouses.....	448	48	.....	496	190	686	75
Coast and Geodetic Survey.....	59	.....	2	61	69	130	21
Navigation.....	34	5	1	40	37	77	8
Steamboat-Inspection Service.....	62	.....	.....	62	17	79	6
Total.....	1,195	92	205	1,492	1,093	2,585	218

^a Includes separations by reason of resignations, discontinuances, removals, deaths, transfers within the Department, and transfers from the Department to other departments or independent establishments.

^b Includes reappointments by reason of change of station, name, designation, or appropriation, extensions of temporary appointments, changes from temporary to permanent status, etc.

It is the aim of the Department to encourage its employees to acquire in pursuance of their duties as thorough a knowledge of the operations of the various services as possible in order that whenever vacancies occur in higher grade positions they may be filled by promotion. This policy leads to efficiency. By having competent employees ready to assume the duties of higher positions under present extraordinary conditions the Department has been able to prevent a serious demoralization of the work owing to the unusually heavy drain on its trained force by separations. This serious drain is shown by the fact that 1,615 out of a total force of 6,398 regularly appointed employees, over 25 per cent, left the service during the year. There were only seven transfers from other departments or independent offices at a compensation greater than the usual entrance salary, and in each case it was specifically shown that the vacancies could not be adequately filled by promotion or transfer within the Department.

Before the war we could secure clerks at the low entrance salary of \$900; we can not do so now. These positions are needed for our work and to have them vacant means that the work is done at the expense of clerks in the higher grades whose duties have been increased because of the war.

The remedy for this situation is a higher entrance salary, but we can not provide this without congressional authority. The Government work must go on, but if it is to be done well it will be necessary to make the entrance salary \$1,200 per annum, eliminating the \$900 and \$1,000 salaries for first-class clerks. A certain number of minor clerical positions, carrying a \$1,000 salary, should continue and can be filled by persons whose services can be utilized for work of a minor character.

The cost of living bears cruelly now upon those who fill the lower salaried positions. It is hardly too much to say that a clerk paid \$1,800 has had his salary cut in half within the last two years by the advance in prices, and for all practical purposes of living he stands where he would have stood two years ago had he then received \$900 per annum. The facts are too well known to require argument. A spirit of humanity alone should lead to a radical readjustment of the entrance salaries.

The following table shows that the average amount of both annual and sick leave used by employees for the fiscal year 1918 was a reduction over that of the previous year:

TOTAL AND AVERAGE AMOUNT OF ANNUAL AND SICK LEAVE, BY BUREAUS, STATED SEPARATELY AND TOGETHER, TAKEN BY THE EMPLOYEES OF THE DEPARTMENT IN THE DISTRICT OF COLUMBIA, ARRANGED ACCORDING TO SEX, DURING THE CALENDAR YEAR 1917, AND THE AVERAGE LEAVE FOR 1916.

MALE.

Bureau.	Number. ^a	Annual leave. ^b		Sick leave.		Total.		Average, 1916.
		Days.	Average.	Days.	Average.	Days.	Average.	
Office of the Secretary.....	77	1,864	24.21	334½	4.34	2,198½	28.55	33.59
Bureau of the Census.....	279	7,954	28.51	1,763	6.32	9,717	34.83	36.76
Bureau of Foreign and Domestic Commerce.....	74	2,067	27.93	536	7.24	2,603	35.27	35.69
Bureau of Standards.....	268	5,636	21.03	954½	3.56	6,590½	24.59	31.33
Bureau of Fisheries.....	51	1,280	25.09	287½	5.63	1,567½	30.72	28.92
Bureau of Lighthouses.....	24	624	26.01	117	4.87	741	33.78	35.80
Coast and Geodetic Survey....	146	3,916	26.82	792	5.42	4,708	32.24	33.83
Bureau of Navigation.....	20	547	27.35	96½	4.82	643½	32.17	31.58
Steamboat-Inspection Service.	8	226	28.25	6	.75	232	29.00	29.44
Total and average.....	947	24,184	25.54	4,887	5.16	29,071	30.70	33.88

^a Only those employees are included who were considered as being entitled to the full yearly allowance of both annual and sick leave.

^b In the count of the annual leave, all periods of one-half day and over were counted as a full day; periods of less than one-half day were omitted.

TOTAL AND AVERAGE AMOUNT OF ANNUAL AND SICK LEAVE, BY BUREAUS, STATED SEPARATELY AND TOGETHER, TAKEN BY THE EMPLOYEES OF THE DEPARTMENT IN THE DISTRICT OF COLUMBIA, ARRANGED ACCORDING TO SEX, DURING THE CALENDAR YEAR 1917, AND THE AVERAGE LEAVE FOR 1916—Continued.

FEMALE.

Bureau.	Number.	Annual leave.		Sick leave.		Total.		Average, 1916.
		Days.	Average.	Days.	Average.	Days.	Average.	
Office of the Secretary.....	39	1,134	29.08	242½	6.21	1,376½	35.29	37.22
Bureau of the Census.....	226	6,773	29.97	2,685½	11.88	9,458½	41.85	40.59
Bureau of Foreign and Domestic Commerce.....	12	357	29.75	94½	7.87	451½	37.62	37.46
Bureau of Standards.....	2	60	30.00	58	29.00	118	59.00	39.00
Bureau of Fisheries.....	19	559	29.42	231	12.15	790	41.57	35.65
Bureau of Lighthouses.....	2	60	30.00	47	23.50	107	53.50	50.00
Coast and Geodetic Survey....	15	443	29.53	191½	12.76	634½	42.29	40.15
Bureau of Navigation.....	3	87	29.00	41½	13.83	128½	42.83	43.80
Steamboat-Inspection Service.....								
Total and average.....	318	9,473	29.79	3,591½	11.29	13,064½	41.08	39.85

TOTAL.

Office of the Secretary.....	116	2,998	25.84	577	4.97	3,575	30.81	34.78
Bureau of the Census.....	505	14,727	29.16	4,448½	8.81	19,175½	37.97	38.55
Bureau of Foreign and Domestic Commerce.....	86	2,424	28.17	630½	7.33	3,054½	35.50	35.95
Bureau of Standards.....	270	5,696	21.10	1,012½	3.75	6,708½	24.85	31.38
Bureau of Fisheries.....	70	1,839	26.27	518½	7.40	2,357½	33.67	30.81
Bureau of Lighthouses.....	46	754	29.00	164	6.30	918	35.30	37.06
Coast and Geodetic Survey....	161	4,359	27.07	983½	6.10	5,342½	33.17	34.30
Bureau of Navigation.....	23	634	27.56	138	6.00	772	33.56	34.13
Steamboat-Inspection Service.....	8	220	28.25	6	.75	226	29.00	29.44
Total and average.....	1,265	33,657	26.60	8,478½	6.70	42,135½	33.30	35.42

By act of Congress approved June 20, 1918, authority has been given for the retirement on pension of superannuated employees of the Lighthouse Service. Retirement is voluntary after 65 years of age with 30 years of service; compulsory after 70 years of age. The payment authorized is one-fortieth of the average annual salary during the last five years of service for each year of total service rendered, not exceeding a maximum of three-fourths of such average annual salary. This is a recognition, late but welcome, of long and efficient service.

The 5 and 10 per cent increase for the fiscal year 1918 has been replaced by a straight \$120 per annum increase (with certain ex-

ceptions) for all those filling what may be considered permanent positions. While this is more equitable to those receiving small salaries, it is only a slight and temporary palliative of the hardship resulting from the constantly increasing cost of living. The average salary of the Government employee is estimated to be less than \$1,200 per annum, and with the \$120 per annum increase his earnings are augmented approximately 10 per cent over a standard which has remained practically unchanged for decades. In the last 10 years the cost of living has increased almost two-fold, for, considering the standard of prices in 1907 as 100 per cent, the same on June 30, 1917, would be represented by 197 per cent.

It is estimated that over 10 per cent of the Department's total force of approximately 10,000 were of draft age. The Service Flag flying from the Commerce Building bears the number 1,824, indicating the Department's contribution of personnel to the military forces of the Nation up to October 1, 1918. The flag also carries three gold stars in memory of those who have rendered the supreme sacrifice. No exemption from the draft has been claimed for any employee. Deferred classification has been claimed and granted, to date, in about 400 cases, these consisting almost entirely of scientists or specialized workers whose duties pertain to war work or preparations. The record of the Department in this respect was published in the Congressional Record of July 9, 1918. There has been a large increase in the number of female employees in conformity with my instructions that during the war and until further notice women should be employed wherever possible. During the past fiscal year 226, or about 15 per cent, of the probational appointments were issued to women, in each instance upon the same conditions as men were appointed. The probabilities are that this percentage will be much increased during the present fiscal year.

I renew my approval, mentioned in previous reports, of continuing the Saturday half holiday throughout the year.

Printing and Binding.

The sundry civil appropriation act of June 12, 1917, allotted to the Department \$400,000 for printing and binding during the fiscal year 1918. Of this, \$394,952.24 was expended, leaving an unused balance of \$5,047.76. The increase in expenditures in 1918 over 1917 was \$12,349.48 (or 3.23 per cent); the allotment in 1917 was \$400,000; the expenditures \$382,602.76.

The estimated cost of unbilled and uncompleted work of the Department at the Government Printing Office on July 1, 1918, was \$64,864.57, while the actual cost of such work at the Government Printing Office on July 1, 1917, was \$69,104.73.

During the fiscal year the Department issued on the Public Printer 2,871 requisitions for printing and binding, an increase of 149 compared with 1917. There were at the close of business June 30, 1917, 501 requisitions which were incomplete, compared with 416 on the same date in 1917.

The following table shows the cost of printing and binding for each of the bureaus, offices, and services of the Department during the fiscal years 1917 and 1918, with the increase or decrease in 1918 for each and the estimated cost of the work on hand but not completed June 30, 1918:

Bureau, office, or service.	Cost of work delivered.		Increase (+) or decrease (-).		Estimated cost of work not completed, June 30, 1918.
	1917	1918	Cost.	Per cent.	
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$15,432.08	\$18,388.96	+\$2,956.88	+19.16	\$1,314.45
Appointment Division.....	373.00	651.23	+ 278.23	+74.59	60.64
Disbursing Office.....	696.21	564.78	- 131.43	-18.88	28.97
Division of Supplies.....	124.85	202.55	+ 77.70	+ 9.58	20.33
Bureau of the Census.....	115,971.35	96,487.31	-19,484.04	-16.80	27,656.48
Coast and Geodetic Survey.....	28,685.67	45,610.93	+16,925.26	+59.00	9,624.28
Bureau of Fisheries.....	16,432.46	15,364.28	- 1,068.18	- 6.50	968.24
Bureau of Foreign and Domestic Commerce.	121,529.73	118,617.02	- 2,912.71	- 2.40	10,756.21
Bureau of Lighthouses.....	18,569.17	18,586.42	+ 17.25	+ .09	886.53
Lighthouse Service.....	4,771.61	6,443.32	+ 1,671.71	+35.03	1,615.30
Bureau of Navigation.....	14,740.06	12,902.86	- 1,837.20	-12.46	19.71
Shipping Service.....	2,491.36	3,440.45	+ 949.09	+38.10	1,119.73
Radio Service.....	589.98	447.29	- 142.69	-24.19	.....
Bureau of Standards.....	23,649.34	35,638.74	+11,989.40	+50.70	6,839.58
Office of the Supervising Inspector General,					
Steamboat-Inspection Service.....	1,009.08	1,760.34	+ 751.26	+74.45	13.26
Steamboat-Inspection Service.....	10,701.05	9,795.13	- 905.92	- 8.47	1,230.17
Customs Service.....	6,775.76	10,050.63	+ 3,274.87	+48.33	2,710.49
Total.....	382,602.76	394,952.24	+12,349.48	+ 3.23	64,864.57

The amount and cost of each class of work called for by requisitions on the Public Printer during the fiscal years 1917 and 1918 are shown in the following statement:

Class.	1917	1918	Increase (+) or decrease (-).	
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Per cent.</i>
Blank forms.....	17, 298, 211	25, 605, 702	+ 8, 307, 491	+ 48. 03
Reports, pamphlets, etc.....	4, 016, 515	4, 560, 340	+ 543, 825	+ 13. 54
Letterheads.....	3, 562, 000	3, 360, 000	- 202, 000	- 5. 67
Envelopes.....	50, 000	58, 000	+ 8, 000	+ 16. 00
Circulars, summaries, and notices.....	384, 475	1, 562, 625	+ 1, 178, 150	+ 306. 43
Index cards.....	1, 837, 400	1, 318, 500	- 518, 900	- 28. 24
Guide cards and folders.....	88, 500	431, 817	+ 343, 317	+ 387. 93
Memorandum sheets.....	1, 586, 000	2, 240, 000	+ 654, 000	+ 41. 24
Blank books.....	27, 191	24, 578	- 2, 613	- 9. 61
Miscellaneous books (binding).....	2, 866	2, 819	- 47	- 1. 64
	<i>Cost.</i>	<i>Cost.</i>	<i>Cost.</i>	<i>Per cent.</i>
Blank forms.....	\$33, 246. 00	\$52, 441. 17	+\$19, 195. 17	+ 57. 74
Reports, pamphlets, etc.....	320, 981. 44	305, 761. 33	- 15, 220. 11	- 4. 74
Letterheads.....	4, 971. 42	5, 380. 60	+ 409. 18	+ 8. 23
Envelopes.....	210. 71	146. 97	- 63. 74	- 30. 25
Circulars, summaries, and notices.....	2, 118. 95	4, 083. 13	+ 1, 964. 18	+ 92. 70
Index cards.....	1, 268. 75	1, 153. 60	- 115. 15	- 9. 08
Guide cards and folders.....	857. 81	2, 779. 80	+ 1, 921. 99	+ 224. 06
Memorandum sheets.....	407. 24	2, 122. 46	+ 1, 715. 22	+ 421. 18
Blank books.....	8, 190. 64	14, 348. 41	+ 6, 157. 77	+ 75. 18
Miscellaneous books (binding).....	9, 513. 53	6, 055. 63	- 3, 457. 90	- 36. 35
Miscellaneous.....	836. 27	679. 14	- 157. 13	- 18. 79
Total.....	382, 602. 76	394, 952. 24	+ 12, 349. 48	+ 3. 23

During the fiscal year 1918 the Department issued 1,141 publications (1,192 during the fiscal year 1917). Those issued in 1918 contained 42,644 printed pages (54,407 in 1917). There were printed for the Department a grand total of 4,804,180 copies (4,444,200 in the preceding year).

The following table summarizes the publication work of each bureau of the Department for the fiscal years 1916, 1917, and 1918. The year 1916 was an abnormal one in both the number of publications issued and copies printed due to the printing and distribution during that year by the Bureau of the Census of 789 advance press summaries of the results of the census of manufactures in 1914, of which 1,200,000 copies were printed, and the printing and distribution by the Bureau of Foreign and Domestic Commerce of 1,500,000 circulars used in the campaign for saving waste paper.

Bureau or office.	Publications.			Pages.		
	1916	1917	1918	1916	1917	1918
Office of the Secretary.....	77	78	70	2,428	3,006	2,860
Bureau of the Census.....	836	135	83	14,165	13,161	4,528
Coast and Geodetic Survey.....	56	62	55	3,960	3,097	5,378
Bureau of Fisheries.....	81	81	91	2,620	2,440	2,852
Bureau of Foreign and Domestic Commerce.....	575	553	544	21,645	17,803	16,372
Bureau of Lighthouses.....	129	111	100	4,361	3,087	3,517
Bureau of Navigation.....	23	22	16	3,207	3,102	1,576
Bureau of Standards.....	150	122	158	8,328	6,623	4,591
Steamboat-Inspection Service.....	18	28	24	988	2,088	970
Total.....	1,945	1,192	1,141	61,702	54,407	42,644

Bureau or office.	Copies printed for Department.			Cost. ^a		
	1916	1917	1918	1916	1917	1918
Office of the Secretary.....	261,850	183,550	231,050	\$6,331.07	\$7,157.60	\$6,909.31
Bureau of the Census.....	1,432,910	645,150	427,875	54,283.37	92,562.23	73,150.95
Coast and Geodetic Survey.....	79,750	109,300	93,600	22,218.71	25,577.94	37,775.82
Bureau of Fisheries.....	171,350	339,700	981,840	10,339.36	11,681.49	13,833.18
Bureau of Foreign and Domestic Commerce.....	4,359,200	2,411,450	2,235,850	120,459.01	114,937.10	107,359.38
Bureau of Lighthouses.....	351,175	270,800	309,050	21,646.99	18,720.83	19,129.80
Bureau of Navigation.....	59,950	52,750	22,065	17,483.47	14,303.72	12,435.29
Bureau of Standards.....	203,050	138,300	238,950	28,209.20	21,202.22	23,154.69
Steamboat-Inspection Service.....	204,800	293,200	263,900	8,062.35	9,870.44	6,634.33
Total.....	7,124,035	4,444,200	4,804,180	289,033.53	316,013.57	300,382.75

^a Figures relate to publications actually delivered to the Department during the year; consequently they do not agree with similar figures in a preceding table giving the cost of work done by the Government Printing Office during the fiscal year. Frequently the cost of a publication is charged against allotments for two or more fiscal years.

The Department's policy of limiting free distribution of its publications resulted in sales by the Superintendent of Documents during the year of 89,808 copies of reports and pamphlets of the Department through miscellaneous sales and 2,884,213 copies by annual subscriptions, a total of 2,974,021 copies. In 1917, 122,896 copies were sold through miscellaneous sales and 3,402,430 copies by annual subscriptions, a total of 3,525,326. Receipts from both sales and subscriptions were \$32,993.59 in 1918 and \$42,461.46 in 1917. The decreases in 1918 are due largely to war conditions, the receipts from sales of publications of the Bureau of Foreign and Domestic Commerce alone falling off \$7,289.52. Coast Pilots, Inside Route Pilots, Tide Tables, and Charts are sold by the Coast and Geodetic Survey, and the receipts from these sales during the year were \$20,194.19. Thus, the total receipts from sales of

the publications of the Department during the past year were \$53,187.78.

During the last fiscal year 3,863,594 publications and printed circulars of the Department were distributed to the public through the Division of Publications, compared with 3,593,563 during the fiscal year 1917, an increase of 270,031.

There were received and acted on during the year 61,538 requests for 568,703 copies of publications, compared with 106,301 requests for 891,971 copies in 1917.

The Department maintains in its Division of Publications a number of mailing lists for use in sending typewritten or multi-graphed information, as well as publications. On July 1, 1918, there were 350 lists, containing 285,877 names.

During the year the Department expended \$2,190.55 for advertising for proposals for furnishing supplies of various kinds, for construction work, and for the purchase of condemned property.

Motor Vehicles.

The present motor-vehicle equipment quartered in the Commerce Building consists of two trucks and two motor cycles, a recent increase of one motor cycle. The 1,500 and 2,000 pound trucks and the older motor cycle were operated during the last fiscal year at a cost per mile of \$0.0944, \$0.0674, and \$0.05028, respectively, as against \$0.055, \$0.057, and \$0.014 per mile during the preceding fiscal year.

The following statement shows the operation and maintenance cost of this equipment:

	1,500-pound truck.	2,000-pound truck.	Motor cycle.
Mileage.....	9,477	10,334	3,481
Operating days.....	281	301	194
Average miles per diem.....	33.73	34.33	17.94
Gasoline consumption (gallons).....	979	1,001	161
Miles per gallon of gasoline.....	9.68	10.32	21.62
Operating expenses:			
Tires and tubes.....	\$323.29	\$345.40	\$9.31
Repairs to tires and tubes.....	14.75	11.63	5.46
Equipment.....	25.42	23.02	28.95
Miscellaneous supplies.....	15.80	15.80	.....
Gasoline.....	219.58	224.52	36.11
Cylinder oil.....	20.68	21.12	3.71
Repairs to machines.....	137.89	24.44	84.09
Replacements.....	137.30	30.10	7.40
Total operating expenses.....	894.71	696.03	175.05

Stock and Shipping Section.

The stock and shipping section received and filled during the year 7,179 requisitions for supplies of all kinds, of which 2,971 were for the offices and bureaus of the Department located in Washington and 4,208 for the outside services. Of the requisitions received 2,703 were for blank forms, 623 for printed stationery, and 3,853 for stationery supplies.

The following table shows the number of books and blanks sent to each of the outside services during the year:

Service.	Blank books.	Blank forms.
Customs Service (Bureaus of Navigation and Foreign and Domestic Commerce) .	9, 271	1, 005, 877
Fisheries Service.....	248	485, 617
Lighthouse Service.....	18, 951	898, 630
Bureau of Navigation:		
Shipping Service.....	7, 876	199, 169
Radio Service.....	286	76, 000
Steamboat-Inspection Service.....	185, 180	724, 992
Miscellaneous.....	25	160, 293
Total.....	215, 837	3, 550, 598

The following statement gives the quantity of each class of printed stationery supplied during the year, both in Washington, D. C., and in the field:

Blank books.....	4, 411	Guide cards.....	111, 337
Blank forms.....	290, 274	Index cards.....	1, 015, 250
Continuation sheets.....	552, 500	Letterheads.....	522, 500
Embossed envelopes.....	3, 000	Memorandum sheets.....	2, 150, 184
Embossed letterheads.....	16, 000	Stenographers' notebooks.....	2, 721
Envelopes.....	6, 833, 875	Vertical folders.....	552, 500

Four hundred and sixty-two orders were placed with the contractors for 7,043,200 envelopes, costing \$8,658.94, of which 5,622,375 were used in Washington and 1,420,825 by services in the field.

Department Library.

During the year 3,396 volumes and 926 pamphlets were added to the library. Two thousand and ninety-six trade and technical periodicals were received, and brought to the attention of officials interested in their contents. There were 3,600 volumes discarded to make room for new material.

Figures do not indicate the amount of work performed in the library during the past year; it has been unprecedented.

In addition to furnishing material to the bureaus of the Department, the library has been opened to all the war boards and commissions, which use it freely. A great deal of time has also been given these services in research work in connection with various investigations, without any increase in the force. The library has proven a valuable and useful instrument in the war work of the Government.

Books to the number of 1,169, donated by clerks for our soldiers and sailors, were transmitted through the library to the Library of Congress.

The Division of Supplies.

At the beginning of the year the Division was much handicapped by losses in its trained personnel, caused by the draft and transfers to war bureaus, but a number of the positions were filled by the appointment of women. By a readjustment in salaries, made possible by separations from the service of higher salaried clerks in other divisions of the Secretary's Office, it has been practicable to better assign the several duties of the Division to clerks who are paid salaries more nearly commensurate to their tasks.

A total of 3,132 requisitions were handled, involving the writing of 4,140 orders and 6,974 invoices. This also necessitated the issuance of 4,027 sets of proposals. The sum of \$204,587.56 was expended for supplies ordered through the Division during the fiscal year, and 4,369 vouchers were audited for payment. In addition to this a representative of the Division inspected 479 tons of coal for the Department.

The sum of \$1,067.08 was received from the sale of old and condemned furniture, office equipment, four horses, three carriages, stable equipment, and miscellaneous other property of no further use to the Department.

Two hundred and seventy-three typewriters were purchased at a total cost of \$18,980.15. As the allowances on old machines amounted to \$2,248.50, the total net cost of these 273 machines was \$16,731.65, or an average price of \$61.288 each.

Liberty Loans and War Savings Stamps.

The subscriptions to the several loans and War Savings Stamps were as follows:

	Subscribers.	Subscription.
Liberty Loan (first).....	2,516	\$500,850.00
Second Liberty Loan.....	3,377	604,700.00
Third Liberty Loan.....	4,793	607,550.00
Total in bonds.....	20,686	1,713,100.00
War Savings Stamps (6 months).....		78,197.71
Grand total.....		1,791,297.71

At this writing subscriptions to the Fourth Liberty Loan are reported as follows: Subscribers, 5,772; subscription, \$841,600. Some of the more distant parts of the field services have not yet reported.

Purchase of Dutch Harbor, Alaska.

I renew the recommendation made in my reports for 1915, 1916, and on page 50 of my report for 1917, that the Government should purchase Dutch Harbor, the abandoned village of the North American Commercial Co. in Alaska.

Foundation for the Promotion of Industrial Peace.

Pursuant to the joint resolution of Congress approved July 12, 1918, the trustees of the Foundation for the Promotion of Industrial Peace at a meeting on July 18, 1918, authorized the American Security & Trust Co., treasurer of the foundation, to return the fund now in its custody to Hon. Theodore Roosevelt. This has been done.

Abolition of the Official Register.

The abolition of the Official Register, for which House bill 2354 provides, would save a waste of paper and labor on a publication which no longer serves the purpose for which it was intended. The card system for which the measure provides would be much less expensive and far more efficient.

Status of Proposed Legislation Affecting the Department.

The following items of pending legislation are deemed of special importance by the Department:

House bill 10236. To prohibit the importation, bringing into, or landing in the United States, and so forth, of lobsters taken in waters outside the territorial waters of Canada and opposite thereto during closed seasons in such waters.

House bill 11984. To provide for the Fourteenth and subsequent decennial censuses. (Passed the House of Representatives July 2, 1918. Now pending in the Senate.)

House bill 10366 (S. 4458). To authorize the adoption, registration, and protection, of a national trade-mark to distinguish merchandise manufactured or produced in the United States of America and used in commerce with foreign nations, or among the several States, or with Indian tribes, and to authorize the Secretary of Commerce to license the use of same, and for other purposes.

House bill 1753. For the protection, regulation, and conservation of the fisheries of Alaska, and for other purposes.

House bill 5338. Extending the benefits of care and treatment by the Public Health Service to seamen on vessels used in the service of the United States.

House bill 2346. To amend section 13 of an act entitled "An act to promote the welfare of American seamen in the merchant marine of the United States, to abolish arrest and imprisonment as a penalty for desertion, and to secure the abrogation of treaty provisions in relation thereto, and to promote safety at sea," approved March 4, 1915.

House bill 2354. To provide for the registry of officers, clerks, and employees in the Federal service, and for other purposes.

House bill 2878. To regulate and control the manufacture, etc., and use of weights and measures, and of weighing and measuring devices.

House bill 10475. For the establishment of a uniform system of weights and measures in the United States.

House bill 6186. To fix and establish a legal or standard crate and a legal or standard basket for tomatoes.

House bill 12392. To authorize the formation and organization of corporations for the transaction and conduct of commerce with foreign nations.

Development of Waterways.

An important step forward, which will be of great advantage to our commerce, was taken when the Director General of Railroads assumed, on behalf of the Government for the period of the war the operation of the Cape Cod and the Delaware and Raritan Canals, the latter being operated in connection with the New York State Barge Canals. Every economic, military, and naval argument points to the importance of the earliest possible development of a Government-owned waterway corresponding with what is commonly known as the Atlantic intracoastal waterway, connecting all the great cities of our Atlantic seaboard with one another, with the New York State waterways, reaching to the Great Lakes and Lake Champlain, and with all the railroad terminals along our eastern coast. Such a waterway, safe alike from the effects of storms and from the acts of enemies, would be a great asset to the Nation if it were available to-day. The development of the use of our internal waterways having been taken over by the Railroad Administration, this Department retains an interest in them only because of their effect in promoting our commerce.

Work of the Solicitor's Office.

During the fiscal year ended June 30, 1918, 118 contracts, totaling \$1,130,529, together with 25 contracts of indeterminate

amounts; 43 leases amounting to \$115,752; 20 revocable licenses, amounting to \$12,240; 4 deeds in the sum of \$6,350; 101 contract bonds amounting to \$289,503; and 50 official bonds amounting to \$285,000, were examined, approved, disapproved, drafted, re-drafted, or modified.

The number of legal opinions rendered, formal and informal (memorandum), totaled 398. Legislative matters handled which concern the Department of Commerce (drafting and redrafting of bills, reports relative thereto, etc.) numbered 418. In addition, 1,999 miscellaneous matters embracing everything submitted for the advice or suggestion of the Solicitor, or for the formulation of Department action, not included in the foregoing items, were handled by the Office of the Solicitor.

In connection with the Solicitor's Office, I point out the small salaries (\$1,400 to \$1,800) paid the attorneys in this office. These attorneys (though classified as clerks) are graduates of law schools and members of the bar. Their duties are those of attorneys and law clerks and require training and legal ability. They are paid much less than those doing similar work in other departments. In fact, these professional employees receive no greater salaries than are paid departmental clerks without professional training. The salaries of these attorneys should range from \$1,800 to at least \$2,500 per annum, to correspond to salaries received by attorneys and law clerks in other departments.

Because of the low salaries paid, the Solicitor's Office has, during the year, lost two of its most competent law clerks. As the employees of this office are under the jurisdiction of the Department of Justice, I have taken up with the Attorney General the matter of making the salaries conform to those paid for similar work in other law offices of the Government. Assurances have been received from the Attorney General that he would be very glad, indeed, to give the matter consideration when the estimates are being prepared for the next fiscal year beginning July 1, 1919. The Solicitor has accordingly submitted estimates providing for the rearrangement of the positions of the attorneys in his office, both in designation and salaries.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

(BURWELL S. CUTLER, *Chief.*)

This Bureau is the national center for economic information and statistics of the resources, transportation, and trade of foreign countries. The past war year brought unprecedented demands for that class of information. At home and abroad the Bureau helped the War and Navy Departments to find new sources of needed materials, in some cases taking part in the actual purchase. Congress, too, and all the war boards sought information about our foreign trade, our raw materials and markets, as well as trade data from foreign countries on their raw materials and indispensable imports. The statistics and facts were available chiefly in the Bureau. Therefore, in addition to the normal function of promoting foreign trade, the Bureau became also a mainstay of economic research for the War Trade Board, War Industries Board, Shipping Board, and other Federal agencies of less intimate contact with trade.

Most of our commercial attachés are representing the War Trade Board or the Shipping Board, some of them having taken part in the economic conferences of the allies on blockade and embargo matters in London and Paris, and all having contributed frequent reports on commercial matters to the above war organizations. Our special traveling agents have collected and turned over volumes of information to the war boards. The Latin American division has time and again supplied specialized information which could have been obtained from no other quarter; indeed, the division has been expanded greatly under the influence of that demand. It is easy to see what great contributions might also have been made by a Russian division and a far eastern division and a western European division had we been fortunate enough to have such facilities at command; much valuable information in respect to those fields exists in the Bureau, but it could not all be organized for use with the means available. The statistical division has been at times absorbed in satisfying the extraordinary and comprehensive demands of the war agencies for minutely classified import and export figures, and this situation has obtained also in a less degree with the research division. It is not too much to say that the Chief and Assistant Chiefs of the

Bureau have labored day and night to meet the war-time demands without allowing the regular functions of the Bureau to lapse.

Balance of Trade in Favor of United States.

The visible balance of trade in favor of the United States on merchandise transactions for the fiscal year ended June 30, 1918, was \$2,982,226,238. The total of our merchandise export trade was \$5,928,285,641 and of our import trade \$2,946,059,403.

Working Policy.

At the beginning of the year the American manufacturer and exporter was still seeking foreign trade where he could find it, and he was encouraged rather than discouraged by the Bureau in his efforts. It was thought proper to supply the needs of the foreign customer so long as there was involved no interference with the war program. Eventually there came a time when the effective prosecution of the war demanded a cutting down of foreign sales to conserve tonnage and materials. Thereupon the Bureau ceased for the time to promote the expansion of present general export business and turned to the problems involved in keeping close touch with the remaining available markets and the close investigation of other markets, so that there would be the fewest possible obstacles in the way of resuming trade when the war ends. Investigations now carried on in foreign fields are aimed not so much at stimulating present business as at supplying our manufacturers and exporters with information that will enable them to meet future competition. This has naturally led the Bureau to consider plans relating to the resumption of trade after the war; the organization is giving attention to the problems of commercial readjustment.

The present purpose of the Bureau is to cooperate to the fullest extent with the national war agencies and not to concentrate attention exclusively on immediate trade promotion, since to do so might handicap our military effectiveness. On the other hand, the Bureau would be remiss in its duty if it did not develop an organization and collect information for the vital period to come. This has been done tirelessly and to the limit of means in men and money, as the following pages will show.

German Trade.

The war aroused keen interest in the trade methods that Germany had used to intrench herself in the markets of the world, and because conflicting opinions and rumors were abroad the

Bureau decided to make a thorough inquiry into the matter and put the truth before the business public in the form of printed reports. The first issued was "German Foreign-Trade Organization," which set forth the development of the German export trade, the organization of German commercial education, the promotion of trade by the German settlements in foreign countries, the German banking and shipping facilities, and the trade-promoting agencies and trade associations. The object was not condemnation of all German efforts, but rather an impartial presentation of the good and bad features, so that the American exporter and manufacturer could profit by what was good as well as avoid what was evil. The report was the work of Mr. Chauncey D. Snow, First Assistant Chief of the Bureau, who was engaged in an industrial investigation in Germany when the war broke out. It was followed by a report, entitled "German Trade and the War," concerned with war-time commercial and industrial conditions in Germany and their bearing on the future trade of that country. The first report was devoted largely to the export trade of the enemy, the second to his raw materials and imports. The second report was prepared by Mr. Snow, in collaboration with J. J. Kral, of the research division of the Bureau. These reports have had wide circulation.

Independence of German Chemicals.

Because the census of dyestuff imports taken by the Bureau in an effort to stimulate the development of an American industry proved effective, the work of completing a similar census of all chemical imports has been pushed vigorously during the last year, with the cooperation of the American Chemical Society. For many years the industries of this country have depended upon Germany for dyestuffs and many other lines of the finer chemicals, and the German exporters have taken good care that particulars of the extent and character of this trade were not made known. The dyestuff census brought this information to light so far as that industry was concerned, and American manufacturers were able to proceed with certainty. The possibility of establishing a self-contained chemical industry in this country is no longer open to question. Germany has definitely lost much ground in our market, and the coming report on prewar chemical imports will make possible additional assaults on former German chemical strongholds.

Defeating German Commercial Plots.

German attempts to register American trade-marks in foreign countries, particularly in South America, were reported to the Bureau at intervals during the last year. Our procedure in cases of this kind is the same as in any attempts to appropriate trade-marks belonging to American concerns; that is, the American firms are notified that marks belonging to them have been offered for registration, and they are advised as to what they may do to maintain their rights. Regulations governing the registration of trade-marks vary in different countries. In this country the person who first uses a mark is considered the owner, even if he does not register it promptly. In many South American countries the man who first registers the mark is the owner. It is easy to see how serious it would be to have any considerable number of American marks pass into German hands in these markets. Some marks have been definitely lost, but others have been re-registered upon proof of fraud in the first registration. The Bureau will continue its watchfulness, but increasing vigilance on the part of our manufacturers is necessary.

The traveling agents and commercial attachés of the Bureau have been in an advantageous position to watch the activities of German merchants and commercial agents in countries where they are still at liberty to plan and plot. Information obtained in this way has been important to the various war organizations of our Government and has enabled the Bureau to anticipate German plans for the future.

Commercial Attachés.

Because of war conditions, the work of these officers has been chiefly given to assisting the special war services—the War Trade Board, War Industries Board, Food Administration, and others.

Mr. Pierce C. Williams, commercial attaché at London, has been transferred to Paris.

Mr. Philip B. Kennedy, formerly at Melbourne, has been given the London post.

Mr. Paul L. Edwards, commercial attaché at The Hague, has been several times called to London and Paris on work for the War Trade Board.

Mr. Erwin W. Thompson, commercial attaché at Copenhagen, has spent much time in London on work for the War Trade Board.

Mr. William C. Huntington, commercial attaché at Petrograd, after actively assisting our ambassador through many trying months, has returned to this country.

The post at Buenos Aires has been filled by Mr. Robert S. Barrett, who represents also the War Trade Board, the Shipping Board, and the War Industries Board in Argentina. He has been intrusted by our ambassador with all enemy-trade investigations.

Mr. William F. Montavon, commercial attaché at Lima, has been active in successfully settling differences between American firms and the Peruvian importers. He was, after the close of the fiscal year, transferred to a new post in Spain.

Mr. William C. Downs, commercial attaché at Rio de Janeiro, resigned, and shortly after the close of the fiscal year the post was filled by the appointment of Mr. J. E. Philippi, who has for years been identified with the American export trade in Brazil.

The work of Mr. Philip B. Kennedy, commercial attaché at Melbourne, has been fruitful in bringing about a kindly commercial understanding between the United States and Australia. His place at Melbourne has been filled by Mr. Augustin W. Ferrin.

Mr. Julean Arnold, commercial attaché at Peking, has long acted as chairman of the International Customs Conference in Shanghai, on which body he represents the United States. During his absence on this duty the post at Peking was filled by Mr. Ferrin, now transferred to Melbourne.

Mr. Frank R. Rutter, commercial attaché at Tokyo, has rendered valuable service in connection with necessary commercial readjustments arising from war conditions.

It is a matter of deep regret that the Department has not been furnished funds with which to increase the force of commercial attachés. Each of these officers has dealt with delicate and important matters with success and self-sacrifice. The commercial interests of the country abroad would be in even better condition than they are had the request of this Department for a larger force of attachés been heeded. There is now an urgent, repeated call from Italy for a commercial attaché at Rome. We hope to answer this call affirmatively.

Trade Commissioners (Traveling Commercial Agents).

These are specialists assigned to investigate particular markets or to study basic conditions underlying the foreign trade of certain countries. They have obtained first-hand commercial information of the greatest importance to the War Trade Board, War Industries Board, Council of National Defense, War Department, Navy Department, Department of State, Shipping Board, and the Railroad Administration. This information has covered such

subjects as trading-with-the-enemy violations, enemy propaganda abroad, opportunities for substituting American for German capital in enterprises of neutral countries, comments on current conditions in Germany, Russia, and Finland, data concerning foreign sources of important raw materials, etc. These agents have thus done their war service in the regular course of their missions on trade subjects.

Valuable assistance has been given by the commercial agents in connection with the war work of the Government in such important matters as current economic developments in Germany, the effect of the war and blockade on conditions in Scandinavia, the status of commercial concerns in South America, the source of supply of boots and shoes in South America, assistance in purchasing supplies for our Army in Spain, data on port facilities and freight conditions in South America, on lumber supplies available in Scandinavia, on the commercial and political conditions in Finland, on the crude-rubber resources of the world, on railways in the Far East and in New Zealand, Australia, and Japan, and the lumber trade in Russia and on industries in that country.

The work thus briefly summarized has been utilized by the War Department, the State Department, the Navy Department, the War Trade Board, the conservation division of the War Industries Board, the Council of National Defense, the Bureau of Mines, and the Geological Survey of the Interior Department, the War Minerals Committee of the War Industries Board, the Shipping Board, the Railroad Administration, etc.

The Department regrets that the necessity for making this report as brief as possible prevents its naming here the various traveling representatives who have done so much in the past year under difficult conditions on behalf of their country. One at least of them was thrown into a Russian prison, and others have had to work in distant places under circumstances of stress or danger. Their work has been well done and they are entitled to the thanks of the country, not only for the quality of the services they have rendered, but for the unselfish and patriotic spirit in which they have done their part.

Investigations Completed During the Year.

Some of the most important investigations ever undertaken by the Bureau were completed during 1918 by these traveling agents. Other investigations of no less importance were started

during the year and have yet to be completed. A brief outline of both groups follows:

The study of the markets for agricultural implements in Australia, New Zealand, and the Union of South Africa was completed.

Reports were published on "Markets for Agricultural Implements and Machinery in South Africa," and "Agricultural Implements and Machinery in Australia and New Zealand."

The study of cotton-goods markets in British India and Ceylon was finished early in the fiscal year. Parts IV, V, and VI of "Cotton Goods in British India" were published during the year. They are concerned with the trade of the Bombay Presidency, a summary of the Indian trade, and cotton manufacturing in India, respectively.

An investigation of markets for electrical goods in Australia, New Zealand, China, Chosen, and Japan was completed during the year. Monographs were published on "Electrical Goods in New Zealand" and "Electrical Goods in Australia."

Inquiry into the possibilities of South Africa and Portuguese East Africa as markets for American hardware disclosed an eagerness on the part of importers in those lands to enter into permanent trade relations with this country. The report of the officer who conducted this investigation will be published soon.

A study was made of markets for motor vehicles in Japan, China, and Hawaii. The report covering these countries is completed and will be issued in the near future.

The study of markets for paper, paper products, and paper machinery in South America and Cuba was completed early in 1918. This field was formerly dominated by German products. Reports were published during the year on "Chilean Market for Paper, Paper Products, and Printing Machinery," "Paper Products and Printing Machinery in Argentina, Uruguay, and Paraguay," and "Brazilian Markets for Paper and Paper Products, Including Machinery."

The well-known popularity of American shoes in those foreign countries where they have been well advertised led the Bureau to undertake a study of shoe markets in Latin America, Australasia, and the Far East. The investigation in Australia, the Philippines, China, and Japan was completed during the winter, resulting in reports entitled "Shoe and Leather Trade in New Zealand," "Shoe and Leather Trade in Australia," and "Shoe and Leather Trade in the Philippines." The survey of Latin American shoe markets was completed. "Markets for Boots and Shoes in Peru"

appeared during the year, and monographs covering Chile and the River Plate countries are in press.

The investigation of Latin American markets for textiles proceeded, but was not completed. The following monographs were published during the year: "Textile Markets of Bolivia, Ecuador, and Peru" and "Textile Markets of Chile."

The increasing importance of manufactured rubber in industry and our dependence on foreign sources for this material led the Bureau to arrange for a study of sources of raw rubber, export methods, and other factors affecting the domestic rubber industry. An interesting feature of this work is the review of experiments with guayule cultivation in the desert lands of our Southern States. It seems probable that within a comparatively short time guayule production within our own borders will become profitable. Conditions prevailing in the rubber-producing regions of Brazil, the East Indies, and other parts of the world are covered in a monograph which will soon be published.

A study of investment opportunities in Latin America was finished during the spring. From the standpoint of United States foreign trade and the furtherance of existing good relations with the South American Republics, our investing public should give more attention to South American opportunities after the war.

Investigations in Progress.

The study of Latin American markets for construction materials and machinery has been completed in Cuba, Argentina, and the west-coast countries of South America. During the year one monograph was published, entitled "Market for Construction Materials and Machinery in Colombia."

The investigation of South American markets for American furniture has disclosed a remarkable development of local industries, but it seems likely that upon the restoration of normal conditions American lines will be sold as heretofore on a quality basis. "Colombian Markets for American Furniture" is the title of the only report issued on this subject during the year.

The investigation of Latin American markets for jewelry and silverware was completed in Cuba and the west-coast countries. Much progress has been made by American exporters in this line since the war started. This investigation is of particular significance, because the South American market has been dominated by European jewelry.

Preliminary work in connection with after-war markets for wood and lumber in Great Britain and France has been completed. Effective work was done in convincing officials and importers that American construction woods are stronger in proportion to size than the softer woods of the Baltic countries. The study of after-war lumber markets in the Spanish Peninsula, Italy, and Greece was begun. All these countries are important future markets for American goods.

The study of timber resources and export methods in Finland was completed. This work was carried on in spite of severely adverse conditions.

The preliminary survey of the Swedish lumber industry is finished. That work in Norway will soon begin.

A study of Russian timber resources has progressed in the face of many difficulties. The investigation of the inaccessible forest regions of eastern Siberia was pioneer work. It is believed that no other reliable information is available concerning the timber resources of this important potential source of supply. The Bureau will continue this work in European Russia, if possible.

The investigation of markets for railway equipment in Australia, China, and Japan was completed during the winter and a voluminous report on conditions in Japan, China, and Chosen will shortly be issued. One report was published under the title "Markets for Railway Materials, Equipment, and Supplies in Australia and New Zealand."

The study of financial and economic conditions in China continues.

A survey of the mineral resources of Japan has been completed and a comprehensive report is nearly ready.

An inquiry into the mineral resources of China, that are destined to play so large a part in the development of that country, will soon begin.

A study of ports, harbors, and interior transportation facilities of all kinds in China and other far eastern countries is being continued. The potentialities of China as a market for American products and a field for American enterprise make such an investigation very desirable.

The growing interest in Latin America as a market for the increasing volume of American exports and the lack of information on the part of the American advertising agencies regarding Latin American advertising methods have led to an investigation of advertising conditions in South and Central America. The

study of these conditions in Cuba and the west-coast countries is completed.

The research work on export marketing methods was not finished because the officer assigned to it was called to important war work by the United States Shipping Board. The work will be resumed and completed as soon as opportunity offers.

An agent was sent to Christiania in January to study economic and commercial conditions in the three Scandinavian countries. He has incidentally sent valuable information concerning current tendencies in Germany and in Russia.

At the request of the United States Shipping Board, the Bureau detailed a commercial agent to investigate the production and export of certain tropical products in Central America and Colombia. He is also obtaining for the Bureau information on commercial conditions in the Central American countries.

Statistical Division.

As the compilation center of all American foreign-trade statistics, the statistical division was, during the year, continuously used by the War Trade Board, the Food Administration, the Shipping Board, the Fuel Administration, the War Industries Board, and such bodies as the Textile Alliance and the Tanners' Council. It is no exaggeration to say that every Government office handling war-trade problems called on the division for special statistical service during the year.

The extra demands for a time threatened to interfere with the regular work of preparing statistics for publication. Naturally the condensed published figures did not always meet war-time requirements, and in most cases it was necessary to go back to the detailed monthly records on file. It was soon found impossible for our few statistical clerks to handle all this work. The staff was materially increased, and arrangements were made to furnish desk room and place the records at the disposal of clerks detailed from the various departments and boards. This has worked admirably. The regular staff has devoted much time to assisting the force so detailed.

Early in the year the war boards suggested that the monthly statistics usually available a month to six weeks after the close of the period which they covered were not sufficiently up to date for their purposes. A plan was accordingly perfected for furnishing them each month with three statistical statements of both exports and imports, each brought up to 10 days from date

This meant a revolution in the methods used at the custom-houses, as well as at the Bureau, but the 10-day reports have been furnished regularly for exports since February and for imports since April. These reports are for the confidential use of the war boards.

To meet the needs of the war boards and of commercial interests for more detailed export statistics for commodities in which the trade has increased since the war, but which have been included in "All other" classes, suggestions were invited from boards of trade, chambers of commerce, and private firms for additional classes. A generous response followed and many suggestions were made. While first consideration is given to the needs of the war boards, the object of making the classification of the greatest permanent value to trade promotion after the war is kept in view. It is now planned to devise an entirely new classification along the lines suggested from the material available in the Bureau and constantly accumulating.

A new schedule governing the classification of imports was issued, effective July 1, 1918. It shows more detail than the former Schedule E, as almost every item mentioned in the tariff is separately classified. This detailed classification was provided for the use of the United States Tariff Commission in its work of collecting information regarding imported commodities as a basis for tariff legislation.

In spite of the press of war work, the division has issued the usual statistical publications without serious delays. Mechanical tabulation will be extended with the beginning of the next fiscal year to all import, warehouse, and noncontiguous-territory reports.

Latin American Division.

The Latin American division has contributed to war work as extensively as any division in the Bureau, except, possibly, the division of statistics; but the fundamental duty of trade promotion has not been neglected. Restrictions upon foreign trade through the curtailment of shipping space and import and export license requirements have retarded our trade with Latin America in many respects, although the trade with the nearer regions of Latin America—notably Central America and northern South America—has been stimulated because of the impossibility of importing certain commodities from the islands of the Far East and from the remoter regions of Latin America. In anticipation of

requests of American importers and exporters for assistance in trade with the Caribbean countries, the division has undertaken detailed investigation of trade problems in these countries. A gratifying response has been observed in the activities of American houses in that field.

Far Eastern Division.

The work of inaugurating a division to handle far eastern commercial matters, similar in scope to the Bureau's Latin American division, was begun during the year. It will centralize matters relating to the countries of the Far East and will have assistants who specialize on each of these countries.

Already the newly formed division has been able to render assistance to the various war boards that are making studies of the shipping and trading situation on the Pacific. In view of the situation in Manchuria and Siberia, it is believed that the division's activities will have a helpful influence in shaping trade policies with respect to that portion of the Far East.

An appropriation of \$50,000 for the development of the division became available July 1, 1918, and it is expected that commercial information concerning the Far East will soon be as well organized as that relating to Latin America.

Division of Foreign Tariffs.

The work of this division has naturally been affected by the war activities of the Bureau as well as of outside organizations, particularly the War Trade Board and the Shipping Board. The division was recognized by the war organizations as a source of information regarding trade restrictions of foreign countries, such as export embargoes and import prohibitions, and requests for such information have formed a conspicuous feature of the division's correspondence during the last year. The growing interest in reconstruction problems has also served to widen the scope of the division's work, so that it covers not only foreign commercial and tariff policies, but also many other phases of foreign business life. Close and helpful relations have been maintained during the year with the Department of State, the Department of Agriculture, and the Tariff Commission.

No other part of the division's work is productive of more good will for the Bureau than that done in connection with trademark priority. Notifications are sent out when evidences of attempts to appropriate American trade-marks are discovered

abroad, particularly in Latin America, and many letters have been received expressing appreciation of this service. Trade-mark attorneys who have visited the division as a result of notices sent to their clients have been surprised at the extent of the trade-mark information available.

District Offices.

For nearly seven months of the fiscal year the various district offices of the Bureau handled the work of the Exports Control Committee, which afterwards became the War Trade Board. During July and August, 1917, more than half of the applications for export licenses made in the United States were presented at our New York office, and more than 15,000 licenses were granted there without the delay necessary had they been sent to Washington for action. On each of several days approximately 2,000 persons applied for export licenses at the New York office.

The branch offices have in other ways assisted in carrying on the war. With the passage of the trading-with-the-enemy act many requests came for advice regarding the interpretation and scope of the measure. Many business houses whose former representatives were placed on the enemy-trade list, particularly in Latin America, appealed to the district offices for assistance in obtaining new connections. In such cases, the district offices often rendered valuable service. They have aided important business houses throughout the country to adjust their operations to the regulations of the various departments of the Government whose decrees tended to check or change the normal flow of commerce.

Many special investigations were made on behalf of various branches of the Government on the abnormal conditions incident to the war. This was true particularly when difficulties arose in connection with foreign shipments, for not only the regulations of this Government but those of foreign Governments changed the natural course of trade. Meanwhile the regular promotive work in many of the offices has increased to a remarkable degree.

The district offices are coming to be looked on as local centers of foreign-trade activity. Foreign visitors frequently make their headquarters at these offices, and visiting consuls, special agents, and commercial attachés always do. The samples gathered in foreign markets by consuls and Bureau representatives are exhibited there to local manufacturers and exporters. The main sample-exhibit room in New York is a revelation of the precise

nature of foreign competition with American goods. The agents in charge of the offices have also taken a prominent part in foreign-trade educational activities, cooperating with the Bureau of Education, the Federal Board for Vocational Education, and local chambers of commerce. This cooperation with local chambers, banks with service departments, etc., tends to give the Bureau a leading part as a national and disinterested party.

Editorial Division.

Commerce Reports depends largely for material on the consular officers, who since the United States entered the war have had their time taken up more and more by activities that have interfered with the normal commercial reports. The editorial division has, therefore, had difficulty in keeping this important foreign-trade paper up to its usual size and standard. By making increased demands upon the time of the traveling agents, commercial attachés, and the Washington staff it has been possible to prevent any falling off in quality. In quantity there was a slight increase during the year, as 4,912 pages were issued as against 4,896 last year. The supplements, which contain the annual reviews of the trade of foreign countries, contained 1,608 pages, a falling off of 127 pages. Five monographs in the Special Consular Series were published as against one in 1917; in the Special Agents Series 26 monographs of 2,609 pages were issued as compared with 27 monographs of 2,344 pages the year before; while in the Miscellaneous Series there was a drop from 24 reports of 2,752 pages in 1917 to 11 reports of 1,112 pages in 1918.

Statistical Preparation for After-War Trade.

The Bureau has undertaken careful statistical studies of the normal world markets for important lines of merchandise, the object being to enable American manufacturers to prepare themselves for trade after the war. The first study published was devoted to the quantities, values, and sources of furniture imported by countries whose transactions exceeded \$500,000 in value. It is issued under the title "Furniture Imports of Foreign Countries." It is planned to issue a series of similar studies of other lines as rapidly as they can be prepared.

New Plan to Stimulate Foreign Trade.

A novel method of Government trade promotion was begun when the Bureau issued the first of a series of Spanish-English pamphlets defining with scientific accuracy accepted American

industrial standards for construction materials. The first pamphlet issued is entitled "Standard Specifications and Tests for Portland Cement" and was prepared by the American Society for Testing Materials, in cooperation with the American Society of Civil Engineers, the Bureau of Standards, the Bureau of Foreign and Domestic Commerce, and the Office of Public Roads. This will be followed by a long series now in press. The standards of the American Society for Testing Materials are already known and used in the Latin American countries, and the decision to publish them in Spanish was reached as a result of numerous requests from these countries for just this sort of information. Care was taken to make the translations idiomatic as well as technically accurate.

Recommendations.

Measured by the economic needs of the country and by the grave responsibility of postwar competition, the Bureau should be expanded substantially in every branch of its service.

New attachés should be assigned to a number of important capitals, especially Athens, Rome, Madrid, Ottawa, Mexico City, and Santiago, Chile. We should also establish at the earliest possible moment resident trade commissioners in Sweden, Norway, Great Britain, France, Greece, Switzerland, Russia, Mexico, Bolivia, Uruguay, Brazil, Colombia, and Venezuela, Dutch East Indies, China, Philippine Islands, British India, Japan, Malay Peninsula, Egypt, South Africa, Australia, and New Zealand. The value of resident representatives is too obvious to require any argument for the extension of this feature of our service.

The field for European investigations by special agents immediately upon the conclusion of the war will be so extensive that the Bureau will require greatly increased funds. Among the more important subjects of these market investigations may be mentioned industrial machinery of various kinds; mill and factory equipment other than machinery; builders' and other hardware; construction materials other than lumber; machine tools; railway equipment and supplies; electrical equipment for industrial plants and small electrical goods; lumber; vehicles, tires, and other accessories; agricultural machinery and implements of all kinds; and kitchen utensils and sanitary supplies and appliances. American concerns have a tremendous field for service to our allies in helping them rebuild and for future business.

Congress does not provide for the service of collecting and publishing statistics of internal commerce. This was discontinued in 1912 for want of an appropriation. There is a constant demand for statistics of commercial movements on rivers, canals, and the Great Lakes, coastwise shipments between Gulf and Atlantic ports, and other phases of domestic trade for which no official statistics are available. The war services have asked information of the kind which we could not supply.

Our shipments to foreign countries by parcel post are rapidly increasing, and the total value of this business probably amounts to several millions annually. The statistical laws make no provision for requiring returns of goods sent by mail, and they are therefore not included in the export statistics. Plans are being considered to remedy this condition.

A weakness of the district-office service is that with rare exceptions there is no second man in the office with qualifications approaching those of the man in charge. This is a serious handicap to the district-office manager and is a particular hardship to the Bureau and to the local commerce when a change takes place in the management of the office. Provision should be made for increasing the force of all the district offices at least 75 per cent and several of them 100 per cent during the coming year, and not less than five additional offices should be established, as there are at present that number of cities in the country in which the business men should be better served by the Bureau. Additional cooperative offices should also be established in the larger cities, which now have vigorous commercial organizations and which feel the demand for the foreign-trade information which the Bureau possesses.

Closely connected with the district-office organization there is a grave need for traveling commercial agents, at least two, who will spend the greater part of their time conferring with business men on the solution of their trade problems at factories and offices where the problems originate. These agents would also tie up all district offices in a unified program of mutual helpfulness and instant response to public demands in ways that can be ascertained only by daily contact with business men.

Too much emphasis can not be placed on the desirability of employing trained economists, statisticians, and experts on banking,

shipping, etc., in excess of the Bureau's present force. These types of economic authority are constantly needed to conduct work equal in importance to that performed by the great Federal commissions in Washington. The Bureau is frequently called upon to undertake tasks outside of its regular routine, such as the dye and chemical census, compilations of foreign embargo laws, surveys of extraordinary economic conditions in Russia, for instance, and other like studies. It is hoped that salaries commensurate with those found necessary by other divisions of the Government for the employment of such experts may be authorized by Congress.

This introduces mention of the Bureau's utter inability to secure employees in competition with other Government commissions and private concerns. In order to meet the increased cost of living, particularly at Washington, and to retain desirable men for whom there is a growing demand in every direction, liberal increases in salaries have come about automatically wherever it was necessary to hold organizations together. The Bureau's disability in this respect has cost it many a valuable employee during the year and has prevented men of the highest qualifications from entering the service. Especially urgent is the need for larger appropriations in the commercial-attaché service to retain the present successful incumbents and to provide for new posts. To the increased living costs abroad, where commodities are becoming scarcer every day, we must add the declining value of the dollar in certain countries, the most notable instance of this being in China, where the rising value of silver exchange has made the dollar worth only about one-half its value of a year ago. The attaché posts are further handicapped by the limit of salaries for clerks to attachés at \$1,500, making it necessary to apply to Congress for post allowances in order to keep these employees merely clothed and fed.

Our country is looking to the Bureau of Foreign and Domestic Commerce to do its share in preparing the country for economic security and prosperity after the war, when the chief industrial and commercial forces in both hemispheres will be ready to launch great organizations on the commercial seas in quest of trade. The instinct of commercial self-preservation demands organized action. This is not the time for short-sighted thrift. Other countries are looking ahead and spending money to organize for their commercial security. A wisely liberal preparation now will

mean millions of income some day to this country, will mean industrial prosperity for our labor, and will mean strength for our economic structure against adverse conditions or sharper competition from any quarter. No country has excelled us in the type of commercial service which we have for six years past rendered to the business community, and this position should be maintained by us regardless of our temporary absorption in military defense.

BUREAU OF STANDARDS.

(Dr. S. W. STRATTON, *Director.*)

The functions of the National Bureau of Standards are the development, construction, custody, and maintenance of reference and working standards and their intercomparison, improvement, and application in science, engineering, industry, and commerce.

When the United States entered the war this service already possessed exceptional facilities, equipment, and personnel for exact scientific research in physics, chemistry, and engineering. This enabled it to take up promptly many important military researches. The Bureau, indeed, cooperated with the Army and Navy, prior to the war, in the development of radio apparatus, in developing automatic devices for recording battleship target practice, the design of optical systems for submarine periscopes and other purposes, the testing of all kinds of supplies, and the furnishing of data in electricity, heat, light, engineering, and chemistry.

The laboratories, so useful during peace, proved of especial importance in war. Instruments, materials, and supplies were on hand which were then almost unobtainable elsewhere. The Bureau promptly extended its service to all lines of scientific work which would assist in the war.

In anticipation of demands the Bureau before the war had begun special researches known to be required. The urgency of many of these problems was not realized even by those in close touch with the situation. The absolute cutting off of the optical-glass supply, the failure of the linen supply, the total lack of ship chronometers, and the necessary uses of light alloys are examples. The rapidity with which the military researches were prosecuted is gratifying, as is the fine spirit of cooperation exhibited. The one thought has been the fullest aid where science could help win the war. The expansion of the Bureau to meet the new demands engaged the most serious attention of the staff, and men and facilities were freely furnished for military work. Practically every section of the Bureau's regular organization has had military problems of the most pressing nature submitted to it, and invaluable service has been rendered.

The recent expansion of the Bureau has been on lines vital to the success of the war. It is interesting to note, however, that many of these lines are of essential value to our industries in peace. The need for the national provision for master-gauge

standardization was only realized by those in close touch with such work. The establishment of a gauge-standardization laboratory has proven an important aid to the mechanical industries. The accurate dimensioning of the functioning parts of mechanisms will permit extending the American system of manufacturing interchangeable parts to its maximum usefulness. The importance of nation-wide standardization has long been known, but the practical working out of such standardization is best met by a national laboratory such as the Bureau of Standards. The same principle holds for all the technologies and special branches of physics. The researches now being conducted for war purposes will prove of inestimable permanent value for the general welfare.

The combination of pure science and technology has proven especially stimulating and effective. The close cooperation of physicists and engineers in practical as well as theoretical work has given an unusual breadth to such researches. In turn, the technologic facilities have proven of great value in the purely scientific work. Many cases might be cited where the elements of a research problem ramify into laboratories of practically every division of the Bureau. The airplane is an example, and a problem apparently as simple as the spark plug has called for experiments in many different sections of the Bureau. The establishment of new industries in America, such as those of optical glass and chemical porcelain, and the scientific remodeling of older industries are fruits of the more intimate cooperation of science and industry which it is the function of the Bureau to perfect.

Aeronautical Research.

During the year scientific problems in nearly all branches of aeronautics have been investigated by the Bureau, comprising material, design, power sources, and technical data. The work is being done in cooperation with the National Advisory Committee for Aeronautics and the military departments of the Government. The primary researches include the development of systems of laboratory tests of all details of airplane design, such as materials, construction, efficiency of form, motor performance, the efficiency of lubrication, carburetion, ignition, choice of fuel, propeller and plane performance, measuring instruments, and the appliances and physical constants required throughout for control. These and other pertinent airplane investigations were taken up in the laboratories of the Bureau under closely simulated service

conditions, embracing such factors as air pressure and air movement, temperature, vibration, humidity, etc.

The engineering testing and investigation covered airplane parts, the use of spruce in airplane construction and mahogany for propellers, the development of instruments for measuring the tension in airplane cables, study of shock-absorbing wheels for airplanes and sea planes, and many others.

A unique feature of the airplane-research program now under way is the development, in connection with the National Advisory Committee for Aeronautics, of a system of free-flight tests made in normal flying as actually practiced by Army aviators. Here the problem is to develop a series of autographic instruments, which during free flight will furnish the primary data for a scientific study of the theory on which airplanes are designed. The six autographic instruments have been designed at the laboratories of the Bureau of Standards, and three have been completed. These will furnish, without any attention from the aviator, a continuous graphic time record during the entire period of flight, showing the engine torque, revolutions per minute, propeller thrust, plane speed, angle of attack, and inclination with horizon.

The epoch-making advance of all phases of aeronautics during the great war has caused experts to realize the strategic importance of perfect control of aircraft with speed and precision. The mastery of the air depends upon such control, which in turn depends upon a whole battery of measuring instruments for indicating position, direction, speed, temperatures, pressures, etc.

The Bureau's aeronautical-instrument laboratory had done fundamental work on the theory of the altimeter and had been testing such instruments for several years before the war began. The staff was promptly increased and now consists of about 35 men. The work of this section is to discover sources of error or improvement in the instruments on which aviators depend for aerial navigation, scouting, fighting, and bombing, and to develop standard testing methods. In one instance, the Bureau's tests caused the rejection of 5,000 altimeters.

The Bureau is now engaged in further researches to promote the operative efficiency of these devices. It has been in close touch with the manufacturing industries in order to make these instruments more reliable and to guard especially against errors due to low temperature, vibration, and centrifugal effects occurring during

the banking of planes. New kinds of dynamometers, for example, have been designed.

Information gained by this section has been given in lectures to aviation officers supplemented by laboratory demonstrations. Many technical conferences with those concerned have been the means of furnishing a great deal of information. Reports have been made covering many aspects of aviation instruments. The Bureau furnished the data upon which the specifications for aviation instruments were drawn for the Signal Corps. The Bureau's experts visit the factories and the factory experts visit the Bureau for cooperation in overcoming errors and improving output. The Bureau staff has not only conducted theoretical and experimental researches in the laboratory under simulated service conditions, but its experts have also studied the instruments in actual flight, including air-speed meters and dynamometers.

The work of aeronautical research required special attention to be given to aerodynamics. A special laboratory for this purpose was built, containing a wind tunnel provided with a wind stream maintained by a 9-foot propeller mounted directly upon the shaft of a 100-horsepower motor. Air speeds of 90 miles were obtained in this tunnel. The purpose of the wind tunnel is to test measuring instruments used on airplanes, to study the design of airplane parts, stabilizing control devices, the efficiency of stream lines, plane sections, etc. For example, the tests included models of airplane and dirigible air-speed indicators, bomb-dropping devices, characteristics of aerial bombs in the wind tunnel, and the like. Incidental uses of the wind tunnel have been made in the study of wind stresses on telephone, telegraph, and electric-power wires coated with ice, and the efficiency of ventilators.

Airplane Power Plants.

At the beginning of the fiscal year, research on airplane-motor problems, such as the radiator and spark-plug design problem, was already under way; this work has greatly expanded and many research problems on aeronautic power plants and accessories have been taken up. An altitude laboratory has been built and put in operation in which aeronautic engines can be tested at the atmospheric pressures and temperatures encountered at high altitudes under service conditions in warfare. One hundred and twenty sets of observations have been made and

results of great importance secured. A dynamometer laboratory has been constructed and equipped with a 400-horsepower dynamometer. This has been of special service in the spark-plug and lubrication investigations.

The effective operation of airplanes at the front depends upon perfecting the essential functioning parts of the engine and also upon the maintenance of the most efficient adjustment of carburetor, lubrication, etc., at all altitudes. The Bureau's work has covered both the design and the working characteristics. A study has been made in particular of spark plugs. Fifty compositions of porcelain were made and studied, and the porcelain which showed the highest performance was selected. In operating the spark plug it became essential to study the various types of magnetos, and favorable results have been obtained. The results of the ignition investigations are being utilized by manufacturers and the various military bureaus.

The Bureau was enabled to locate serious faults with the carbureting systems when operated at high altitudes, and, as a result, a radical improvement may now be expected in this equipment.

More than 100 radiator designs for airplane use were tested out. New features are to be undertaken with a view to the most effective design. Valuable results have been obtained in the investigation of lubricants, and since the lubricating problem is a vital factor in airplanes, these results are important in that field. Tests have been made of various models of the Hispana-Suiza and Liberty motors as to performance, durability, lubrication, etc.

The basic scientific problems are being attacked in these researches which, when correlated with related work in other parts of the Bureau, will mark a distinct advance in airplane construction and operation.

Standardization of Munitions Master Gauges.

A particularly urgent need upon our entrance into the war was for an adequate supply of standardized master gauges for making munitions. Such gauges are a fundamental requisite. The Bureau had already begun such gauge work in its weights and measures laboratories. A matter so vital to the increase in munitions called for by the declaration of war caused the Bureau to anticipate this need, and it actively prepared to take

up the work to meet the demand to come from the military departments and munitions industries. The rapid organization of the technical and mechanical force to handle the great variety of gauges required for producing munitions has been a fine achievement; its success is unqualified. The Bureau's chief expert in charge has entered the military service to cooperate in this work of gauge testing for the arsenals and munitions plants. Before the war only one member of the Bureau staff was engaged in this work; at the close of the fiscal year a staff of 140 was busy in it. A branch gauge laboratory has been established in New York City, and laboratories in Cleveland, Ohio, and Bridgeport, Conn., are to be opened soon.

The testing of master gauges is perhaps the most fundamental and exacting kind of work in connection with war materials. So important are the dimensions of gun parts and shells that accuracy of fire, safety, and durability of guns depend upon the precision of the gauges by which the gun parts and shells are measured. The tests are made promptly and the gauges returned at once with the reports of the tests. In July, 1917, 244 gauges were tested as compared with 5,559 gauges during the month of June, 1918. Within one month 150 master gauges were measured for one type of gun alone. The gauge section has a shop for the construction of special apparatus required for the rapid and accurate testing of complicated gauges. About 50 machines have been manufactured in this shop for measuring screw threads and profile gauges. The staff has been of particular service in the salvage and building of gauges required for exigency needs. This has saved valuable gauges and has avoided the serious delay required to produce new gauges. Of the 27,865 gauges tested during the year, about 60 per cent were for the Army Ordnance Department, 15 per cent for the Motor Transport Division of the United States Army, 10 per cent for the Signal Corps, and the remainder for other branches of the Government and war-essential industries.

Optical Instruments and Light.

The Bureau's optical staff has rendered most important service in connection with the war. This includes the manufacture of optical glass, the design and construction of new optical instruments for military purposes, the testing of such instruments and others purchased for war use, and also highly technical work on radiometry, spectroscopy, and colorimetry.

The technical staff in optics has aided in the design of optical systems for periscopes, airplane cameras, long-distance cameras, gun-sight telescopes, stadimeter telescopes, field glasses, etc. The Bureau has especially cooperated to bring about quantity production of the instruments essential to the Army and Navy. More than 2,000 instruments and parts have been tested. These are mainly American instruments made of American optical glass. The high standard of perfection attained is a gratifying result of the active cooperation between the military departments, the Bureau, and the industries.

Closely related to the above are the applications of optical methods during the year to the measurement of the expansion of such materials as standard steel gauges, fused quartz, and optical glass. The Bureau has perfected instruments and methods for standardizing methods of turbidimetry, a new and important branch of measurement applicable, for example, to smoke, fog, dusty gases, muddy rivers, ocean turbidity, and the special cases of optical glass, crystals, opal and milk glass; in fact, wherever solid suspensions are an important factor. The industrial applications include tanning, dyeing, paper manufacture, a control of city-water filtration, the regulation of the maximum smoke and dust permitted to be discharged into the atmosphere in the cities, and numerous others.

With the advent of the war foreign sources of optical glass were cut off, and, of course, no German glass could be obtained. The French and English needed every pound of their own production and were unable to meet their own requirements. The problem of producing glass of the kinds and qualities required for military purposes was a most serious one. The need for the most perfect obtainable binoculars, camera lenses, optical systems for periscopes, range finders, and optical glass for other purposes could scarcely be overstated, as in a very real sense such optical-glass products are the eyes of the military services.

At the time we entered the war the Bureau had been actively interested for several years in the problem of producing optical glass in the United States. It was believed that this country could be a producer of optical glass, and the Bureau planned to do its part in stimulating such production, both by experiment and research and by the closest possible cooperation with the industries concerned. When we became a belligerent the problem was no longer one of national pride or revenue or independence of

foreign supplies. The production of optical glass in America became an acute, vital, and immediate necessity. The Bureau, therefore, promptly expanded its force and assigned the needed assistance to the existing glass section of the Bureau, with instructions to develop the methods of producing optical glasses of all varieties required, on a commercial scale. The technical literature contained a sufficient variety of acceptable formulas, but little as to technique. Experiments were conducted by the Bureau, and every detail of the manufacture was worked out by study of theory, by actual experiment, and by the study of each factor affecting the optical quality of the glasses produced. The result was gratifying. The Bureau has developed the types of optical glass required for military purposes in the war, and has produced them on a commercial scale. It is now supplying optical glass in quantities made in its own shops to be used for the manufacture of optical instruments. The glass is of excellent quality. The Bureau also made the clay pots in which the glass was melted. Strangely enough, the problem of producing suitable clay pots for the purpose was one of the fundamental problems in quality production—one which had not been solved by private manufacturers. The Bureau determined the clays suitable and the methods of making the glass pots. It actually produced the pots in the quantity required for its own work and furnished the industries with directions for making them.

The Bureau has fully cooperated with all glassmakers in producing a supply adequate for war purposes.

The study of the defects in optical glass will prove useful in all future work on this subject. Methods are now available at the Bureau for studying bubbles, stones, and striæ, and the effects of such defects upon the resulting image. Gratifying success resulted from the effort to produce optical glass whose surface would remain unimpaired. This result was obtained through the control effected by the study of the weathering and other properties of optical glass.

The Bureau has established an efficient optical shop for developing and constructing new optical instruments and devices. The optical glasses manufactured in the Bureau's glass section have been worked up into planes, prisms, mirrors, and lenses, as required. It has produced optical devices of the highest grade of workmanship. The various divisions of the Bureau have thus seen enabled to make use of optical systems in entirely novel ap-

plications. It is needless to say that the results will be available for industrial use wherever the principles are applicable.

Tests of the nonshatterability of laminated glass without undue loss of light transparency showed the material to be useful in the development of eyeglasses, goggles, face masks, and wind shields, to prevent the splinters produced in accident from injuring the eye, especially in the case of aviators and certain industrial workers.

Important investigations in radiometry have been made during the year. Standards of radiation in absolute measure were inter-compared. Methods were developed for measurements required in the life tests of incandescent lamps. The effect of radiation on balloon fabrics was studied experimentally. The rising temperature of the fabric when exposed to solar radiation was measured, using the precision thermocouple. A small-size model balloon is now being used for this study. Extensive data have been obtained of the photo-electric sensitivity of molybdenite, in view of possible important applications of these properties. The Bureau's work on glasses for protecting the eyes from injurious radiations has been extended by gathering new data on the transmission of the invisible ultra-violet and infra-red radiations. The Bureau has furnished data on various phases of radiation for military applications.

Mine and Railroad-Track Scales.

The mine-scale work of the Bureau of Standards, for which Congress made special provision for a nation-wide investigation, is of special interest, in view of the need for maximum output of coal at the mines. Disputes over weighings cause strikes, loss of time, and reduced output. The Bureau experts were called upon, and they found the conditions wholly unsatisfactory. In one case a 2-ton scale was 616 pounds in error against the miner. Improper installation, faulty methods of weighing, and errors were corrected and mines greatly improved. Indictments were found and fines imposed on the evidence of Bureau experts. A general awakening and improvement have resulted, and the prevention of strikes and the renewed satisfaction of the miner has gone far to maintain conditions favorable to a maximum output of coal at the mines.

Since 1913 the Bureau has been testing master scales and general track scales throughout the country. The hearty cooperation of State officials, railroad companies, weights and measures inspectors, shippers, and others has insured the success of the

work. The Bureau is called upon to settle disputes, to test the master scales by which the local track scales are adjusted, and to advise as to methods of operating such scales and keeping them in effective condition. This work becomes of special importance in view of the Government control of railroads. The vast freight revenue is based upon the weighings of these scales. The Director General of the Railroads has, therefore, authorized the Bureau to make tests and reports on railroad scales or test cars. During the year new units have been added to the traveling test equipments of the Bureau. Tests of 583 master and track scales were made, of which less than half passed the test. Of the industrial scales 36 per cent and of the railroad scales only 42 per cent were able to meet the requirements. In addition, the Bureau calibrated 31 test cars owned by the railroads. As a primary standard for this entire work a master scale has been ordered and completed. A suitable housing for it is now required with an auxiliary laboratory for calibrating the test-car weights.

Standardization of Timepieces.

The time laboratory of the Bureau maintains a precision standard clock of the Riefler type corrected from the noon signals from the Naval Observatory. The Bureau's clock in a recent 54-day run exhibited remarkable accuracy, maintaining a constant rate within 0.15 of a second and a net change of rate during the 54 days of 0.01 of a second. The standard clock is connected electrically with the laboratories, which require precise time measurements. The Bureau has for several years been equipped to test timepieces in the most rigorous manner for the Government and the public. The complete lack of ship chronometers on the American market at the outbreak of the war made it necessary to secure substitute timepieces. This was done by the Bureau in cooperation with the Emergency Fleet Corporation. More than 5,000 timepieces have been tested within the year, practically all for the United States Shipping Board, the Army, and the Navy.

Sound and Acoustics.

An interesting feature of the Bureau's work has been the development of its laboratory for the study of sound. This has been placed upon a practical basis during the year by the acquisition of much-needed equipment. The applications of acoustics to warfare have been quite important. These include elements in the problems of sound ranging and the detection of submarines,

airplanes, and enemy operations by acoustic methods. Devices have been perfected which analyze sounds into their components. A special study has been made in the sound laboratory of the photographic analysis of sound waves with particular reference to the improvement of airplane-engine mufflers.

Electrical Research and Testing.

The electrical work of the Bureau is of two kinds—first, the establishment and maintenance of fundamental standards for all electrical measurements used in research and engineering (involving researches in the most refined methods of measurements and the most delicate and precise apparatus); and, secondly, engineering applications of electricity, including a limited amount of testing of commercial instruments and products. All this work is important for the business of war, as well as that of peace. Important service was rendered to the military departments in the standardization of electrical equipment for military use, the formulation of proper specifications for the purchase and testing of such equipment, and the development of new and hitherto unavailable equipment for the new exigencies. The Bureau made tests of electrical blasting devices for firing trench mortars and mines, and redesigned these machines with great reduction in their weight and cost and increase in their reliability. Extensive investigations of the electrical ignition systems for airplane and other gasoline engines have been carried out. This, combined with the Bureau's work in ceramics, has resulted in a great improvement in the quality of spark plugs made in this country. An extensive comparison of magneto and battery systems of ignition has also been made with the promise of marked improvement. Specifications have been prepared and revised after experimental laboratory work under controlled temperature conditions. The large number of such batteries used for military purposes and the extreme importance of their unvarying and proper functioning make this problem one of unusual importance and urgency.

In the field of special illuminants the Bureau was able to assist the military departments in developing trench flares, portable acetylene lights, and field searchlights. The Bureau is testing self-luminous paints. Radium has had direct application to military uses as a component of self-luminous materials employed extensively on the dials of aeronautic and other instruments used at night. In the important field of X-rays, special attention has been given to the development of protective materials

to safeguard the users of X-ray equipment, and gratifying results have been obtained in the improvement of this class of material. The novel methods of magnetic analysis developed at the Bureau for testing steel rails and other magnetic materials are now being used in testing steel for rifle barrels with the object of materially speeding up the production of rifles.

While the commercial and engineering work of the Bureau has found direct military application, its highly specialized staff and equipment, however, ordinarily engaged in refined research in more or less abstract scientific questions has been turned directly upon the development of scientific instruments for use in the war and the solution of other war problems, some of which have long puzzled the naval and military authorities. Much of this work is of a confidential nature.

Special equipment has been designed for the measurement of the velocity of projectiles, and the Bureau has contributed in no small part to the methods now in regular use for this purpose. Another important field in which successful work has been done is the development of equipment for locating hostile batteries on land and for detecting subterranean sounds. In the field of radio communication, the Bureau has contributed the designs of various instruments, has made extensive tests of materials for use in such apparatus, and has contributed large numbers of completed instruments. It has served also as a source of supply for highly trained men for the military radio service and has prepared circulars which are serving as the most up-to-date textbooks in the service radio schools.

Public Utilities.

As a result of the research and testing done by the electrical division, important work has developed on public-utility services, such as electric light and power, gas, street railway, telephone, and heating service. The Bureau had already contributed materially to the establishment of public-utility standards for several of these services. It has also promoted with marked success the practice of settling disputes on the basis of sound engineering and of cooperation between interests rather than by litigation, and in so doing has attained an enviable position as an impartial mediator. During the past year the abnormal conditions gave rise to many cases in which readjustment of service standards or of rates has been called for and the public-utility staff of the

Bureau has been called upon for an extraordinary amount of work. Congress in providing a special appropriation made possible important additions to the staff toward the close of the year.

In the field of gas service the Bureau last year carried out extensive tests on the relative usefulness of different qualities of gas. The results obtained this year found wide application where the fuel supply necessitated change of quality. Manufactured gas is a most available source of toluol, a material essential in the manufacture of munitions. The Bureau's experience in connection with gas manufacture enabled it to contribute important data on methods of recovering toluol, to give valuable advice to military authorities in the formulation of contracts for the construction and operation of toluol plants, and finally to assist in a readjustment of gas-service requirements to allow the removal of toluol and benzol from the gas.

In the field of electric service a wider adoption of the National Electrical Safety Code developed by the Bureau has been secured during the year. This code covers most completely the construction, operation, and maintenance of electrical plants and is contributing materially to the adequacy of service and uniformity of requirements throughout the country, as well as the effective safeguarding of life and property. The Bureau has assisted various cities in reducing the damage from stray electric currents, and despite war conditions active work in this line has been carried on during the past year. Particular success was had in reconciling conflicting interests without recourse to the courts. A striking result is that in some communities damage by electrolysis has been practically eliminated by methods which have actually been profitable to the electric railway companies because the saving of power more than offset the expense of the work.

In the field of telephone service the Bureau has for several years been engaged in laying thorough foundations for future work. The development of an acute situation in the telephone-service situation of Washington gave occasion for the service to take up this problem actively. While time did not permit a thorough-going study, we contributed material information highly useful in future consideration of telephone-service requirements.

In all such public-utility work the importance of a central agency to correlate the activities of the numerous State and city authorities can hardly be overemphasized. Even if it were

possible it would be uneconomical for each State commission to maintain an engineering staff capable of solving all the questions which arise.

Heat and Temperature.

The important applications of heat measurements in the industries and the need for standardized equipment for this purpose have made the heat laboratories of the Bureau of special service to industries engaged in the technology of materials and in technologic research generally.

An important investigation of the fire-resisting properties of structural materials has been conducted to furnish architects, construction engineers, builders, State and city building bureaus, insurance interests, and others with basic data for the efficient design of structures with a view to a minimum fire loss. In the study of fire-resistive properties of materials, structural steel columns were specially investigated. Many such columns with and without protective coating were tested in a specially devised furnace. The research showed that unprotected columns which would fail in half an hour, if properly protected by concrete or other material, would remain intact for eight hours. The resistive property of concrete columns was found to depend largely upon the aggregate used. Quartz aggregate proved specially resistive. Seventy-five steel and iron columns were tested during the year, all designed according to standard current practice with a view to excellent workmanship.

In addition to the above, 40 columns of reinforced concrete were submitted to fire test. The columns were subjected to pressure such as is encountered in structures and were mounted within a gas-fired furnace. Valuable results were obtained which will greatly aid in the effective design for similar columns in actual use. The column research is typical of the Bureau's investigation of the fire-resistive properties of materials. It has already yielded valuable information and promises further results of importance to the building industries.

The work of testing temperature-measuring and recording devices continued. The practice of using misleading clinical thermometer certificates has been broken up. Publicity resulted in stopping the use of those certificates to which the Bureau objected. Our experts have visited the factories in which clinical and other thermometers are made with a view to more effective cooperation with this important industry.

The subject of airplane thermometry was investigated; we aided in preparing specifications for several types of thermometers for airplanes.

The Bureau is now conducting check tests of samples of materials to control the quality of deliveries on war contracts.

An example of an important physical constant is the solidifying point of naphthalene which the Treasury Department uses in the collection of duties. The Bureau developed a standard method for determining this point, prepared detailed specifications for the method and the temperature-measuring instruments to be used, and will distribute standard samples of naphthalene for use in other laboratories.

The high-temperature scale is maintained through the melting or freezing point of certain pure metals, such as zinc, aluminum, and copper. Standard samples of these metals were prepared during the previous year, and many of these samples were distributed to the metallurgical industries in standardizing the master instruments for checking the pyrometers used in these industries. The special demand for these samples from the arsenals, navy yards, and war-essential industries has exceeded our capacity to produce them under war conditions. The standard analyzed samples of sugar and naphthalene have enabled users of calorimeters to check the accuracy of their own instruments. This is especially important now that large fuel contracts are based on the heat value of the fuel.

The study of low temperatures down to that of liquid air is provided for by special machinery housed in a building constructed for the purpose. This equipment has been of the utmost service to the various research laboratories of the Bureau as well as to others. The variety of applications of low temperature in various industries is remarkable and is steadily increasing.

Researches on Metals and Alloys.

Metals are so vital a factor in the war that the division on metallurgy has been able to render important service. During the year a new building was completed for the metallurgical work, which is now installed in its new quarters. This laboratory contains a foundry, heat-treating and mechanical plant, rolling mill, power presses, shearing equipment, drawing bench for drawing metal tubes, and a machine shop, thus enabling the Bureau to prepare and investigate alloys, both ferrous and nonferrous, of all kinds.

The year's work comprised the examination of gun metals, light alloys for aircraft, many alloys for special military uses, and pure metals required for technical purposes. The foundry has made 2,249 separate experimental castings during the year. The recent development of light alloys has opened a new chapter in industrial work. The Bureau researches on alloys were given special impetus by the visit of its chief expert to the battle front in France for the study of gun metals and aircraft alloys under war conditions. Light alloys are essential in aircraft, where both lightness and strength are required. It developed that metallurgists were unacquainted with the physicochemical data concerning aluminum and its remarkable series of special alloys. Circulars were, therefore, prepared for technical metallurgists and users of such alloys, and a consolidated circular on this important subject is in press. Many compositions in this series were cast and rolled for the Bureau and studied in its laboratories.

Substantial progress has been made in the study of fusible metals, the melting points of which control the functioning of such devices as automatic fire sprinklers, safety plugs for steam boilers, and others. The output of fusible tin plugs used as safety devices in steam boilers is controlled as to quality by the Bureau's researches. The work in metallurgy has covered numerous other subjects. Low tin solders, bronze, and bearing metals have been developed to aid the War Industries Board in conserving of tin. The serious erosion of machine-gun barrels was the object of a special technical study.

Experimental work was done to establish standards of uniformity for the copper plugs used in testing powders. Standards of composition and thermal treatment were developed for the special metals used in aeronautic instruments.

In the research foundry, methods were developed with respect to standard Government bronze, and details are soon to be published. Standards are being developed for molding sands which we believe will save 90 per cent of the so-called "burnt" sand. A standard method of determining carbon content of steel, devised during the year, permits complete determination in less than five minutes. A convenient method for determining nitrogen has also been devised, as well as new forms for determining other gases.

The great variety of investigative tests includes many novel ones, such as centrifugal steel casting, a new process for obtaining sound steel of a fine uniform quality; investigative tests of armor

plate; studies of the uniformity of electroplated coatings, and of zinc sherardized coatings, tarnishing, working temperatures of machine-gun barrels, structure of gun forgings, suitability of metal for airplane-motor valves, machine-gun barrels, rifle bullets, and the causes of failure of airplane-engine parts. The above shows the range of the Bureau's work in metals. To this should be added the full cooperation which the metal experts have always accorded the military bureaus on metal problems and in the development of standards of quality of metals for war purposes, notably the excellent series of "International Aircraft Standards," developed in cooperation by the Bureau and the technical representatives of the Allied Powers.

Testing of Instruments and Materials.

Apart from scientific researches and technological studies, the Bureau during the year has conducted thousands of tests, many of an investigative character. Examples, in round numbers, will indicate the magnitude of this work. About 18,000 thermometers were tested, including 13,000 clinical thermometers. About 200 tests of thermocouples and pyrometers for high-temperature measurements were made. The metallurgical division made 1,289 thermal analyses, heat treatment, and other kinds of metal tests, besides more than 2,000 separate castings for experimental purposes. About 2,000 tests on military optical instruments were made in the optical laboratories. The chemical work included 18,000 chemical tests during the year. It is now growing rapidly, and 30,000 tests will probably be made during the coming year. The Bureau certified 3,500,000 barrels of cement for the Government departments and tested more than 5,000 timepieces, nearly 3,000 pieces of volumetric apparatus, and 28,000 precision gauges.

In general the testing work, especially of military supplies and equipment, has increased greatly. In order to keep pace with the increase beyond the capacity of the regular staff, the Bureau secured the cooperation of the War Department through detail of technical experts from the Army to assist the experts of the Bureau.

There is a growing tendency on the part of the military departments to improve standards of quality and performance. Without these, competitive buying may be more harmful than helpful. In this work the Bureau has extended the use of its facilities to the utmost.

Materials.

The measurement and investigation of the properties of materials have in recent industrial practice become a vital necessity. In no other way than by an exact knowledge of these properties can high efficiency be had. The successful war work of the Bureau was possible because it had *already* studied the properties of materials useful from a military point of view—for example, optical glass, light alloys, gun metal, cotton fabricated as substitute for linen in airplanes, low tin solders, and the like.

Our work on structural materials was immediately applicable to the construction of cantonments and other military structures, upon many phases of which the Bureau was consulted and rendered aid. It actively experimented and assisted paper manufacturers in the development of the new cantonment board which is far superior to the older wall boards. The Bureau has investigated such structural materials as steel, cement, brick, limestone, paints, roofing material, including both bitumens and roofing plate. Miscellaneous materials investigated and tested are lubricating oils, rubber, leather, textiles, paper, glass, clays, and clay products ranging from terra-cotta tiling to the highest grades of porcelain. In this connection a striking feature of our work is the close union of the practical manufacture on an experimental scale of the materials studied with advanced theoretical studies of the contributory sciences bearing upon such materials. An example of this is seen in the control of American clays through the application of physical chemistry. The Bureau is enabled by this close relationship to make immediate practical application of the principles of science.

In order that the experts in the various laboratories may have definite and known samples to work with and for the purpose of trying out or developing new methods, small manufacturing units have been installed, including a paper mill, rubber mill, optical-glass works, cement mill, and the textile mills which are about to be installed in the Bureau's new laboratory.

In this connection may be mentioned the important fact that a fine laboratory for industrial research is now under construction and will be ready for use in a few months. This laboratory when completely equipped will be one of the most effective of its kind in the world. In no national institution in the world is the union between pure science and practical technology so intimate as in the work of the Bureau of Standards.

Chemistry.

The chemical work of the Bureau was transferred to the new chemical laboratory early during the year. The staff has expanded from 58 to 146, partly by the detail of chemists from the Army to assist in military testing and research. The work has already outgrown its new quarters, and the laboratory is now housing 25 per cent more work than was planned for it.

The chemical division serves all the scientific and technical divisions of the Bureau, and also renders important service to the industries by the standardization of chemicals and reagents and by devising new methods of analysis and improving existing methods. Practically every military problem involves at some point a chemical question. The entire chemical staff of the Bureau has been placed at the disposition of the military branches for technical consultation, and much service has been rendered informally in this manner, as well as by manuscript reports and printed scientific and technological papers.

In connection with the balloon-gas research the Bureau gave technical advice based on experiments which have effected a large daily saving. The chemists of the Bureau assisted the Food Administration in the conservation of materials, such as ammonia, required by the refrigeration industries. The Bureau has also done work on the standards of quality in chemical reagents, a work of a character as fundamental to chemical science as gauges and measures are to the mechanical industries.

By means of these samples the chemical laboratories in the metal and other industries test the accuracy of the analyses made by their chemists. The samples also permit the testing of the accuracy of new and modified methods of analysis. Incidentally they have proven of value in connection with educational work in chemistry.

The system of standard analyzed samples has had a most gratifying development. This year the Bureau has placed the work on a more independent and business-like basis by a special appropriation for the purpose.

Standardization of Sugar Technology.

Owing to the necessity of increasing to the greatest possible degree the American output of sugar, the entire machinery of the industry is overtaxed and upset. Many new problems demanding solution at the earliest possible date have arisen. Additional facilities and assistance were required to attack them. In order

to begin the work Congress granted an appropriation of \$20,000 to be used for the standardizing of sugar-testing apparatus and the development of technical specifications for the various grades of sugar with particular reference to problems made pressing by war conditions.

The United States has the largest and most diversified sugar industry in the world, including, as it does, the cane and beet industry, a great refining industry, a maple-sugar industry, a large sirup industry, and a very important Government interest due to the collection of a revenue from an import duty. The widespread demand for technical assistance in these matters is shown by the fact that an entire edition of 1,500 copies of the Bureau of Standards' circular on sugar was purchased by the public in less than three weeks.

The Bureau's Work for the Soldier.

The applications of science to military uses are illustrated by several examples of the Bureau's work directly affecting the comfort and efficiency of the soldier. The soldier's shoes are investigated in the laboratory and in the field to determine the most suitable leather. A sole-leather-testing machine is used, and the leather is chemically investigated while controlled service tests are in progress by the soldiers in camp. The serviceability of shoe strings has also been under test. Uniform cloth has been under careful investigation for some time in the textile laboratories of the Bureau. An expert was dispatched from the Bureau to England and France to study the quality and serviceability of Army-uniform material, while in the laboratory the Bureau has been making searching examinations of the various fabrics designed and submitted. It has assisted in developing and selecting from the available materials the present standard uniform button.

The heat conductivity of the soldier's blanket has been studied. Cotton blankets may equal wool blankets in this respect. The Bureau has investigated shelter tents, the soldier's canteen, and other kit equipment, washing and shaving soaps, combs, inks, and other supplies for the soldier's use.

The Bureau also determined by careful tests the most suitable trench oil stove, taking account not only of its heating efficiency, but the danger of observation from the light radiated on the ground. It has standardized the gauges for making the service rifle, has studied the problem of gun erosion, and the failure of gun parts and material in service. All the men in the Navy carry an

identification tag devised by and prepared according to specifications developed by the Bureau of Standards. In short, there is scarcely a phase of the soldier's needs and activities in which the Bureau has not cooperated with the military departments to secure the most effective provision for his comfort, convenience, and fighting power.

The Metric System.

The War Department early in the war decided to adopt the metric system for use in connection with maps and gun-firing data. The Ordnance Department has also adopted standard metric-dimensioned guns, such as the 37-millimeter, 75-millimeter, and 155-millimeter models, and this involves corresponding changes in shell sizes. These uses of the metric system made it desirable that the Bureau of Standards issue for the information of the soldier a small manual. This has been prepared for publication early in the coming fiscal year. Furthermore, there is a demand for metric literature for the various officers' training camps, cantonments, radio schools, aviation schools, and other military organizations. The Bureau has supplied for these purposes the graphic chart of the international metric system, together with a descriptive pamphlet and table of equivalents. The latter has proven of great value in connection with the manufacture of war supplies by various war industries. Publications which have proven of great assistance in developing export trade are in demand for military purposes and will be of increasing value for trade purposes upon the conclusion of peace.

The Importance of Guaranteed Standards in Industry.

The functions of the Bureau of Standards should be so enlarged as to permit the maker of any standard commodity to submit a specimen of his product for examination and to provide that the Bureau, after such an examination, should certify to the facts that a buyer, domestic or foreign, ought to know respecting the nature of the article. The manufacturer should be permitted to attach a copy of the certificate to all of his production of the particular kind and quality so certified. Severe criminal penalties should be provided for willful violation of the manufacturer's agreement to attach the certificate of the Bureau of Standards only to goods coming fully up to the certified sample. It is not intended that certification should be compulsory. The whole matter should be voluntary action on the part of manufacturers.

When, however, a certificate has once been issued, the standard of all goods bearing the certification must be kept up to the standard certified, with heavy penalties for violation. It seems only necessary, in order to bring this about, to have legislative authorization for the Bureau to issue such certificates with a penalty clause dealing with the improper use of them.

Something of this nature has already been done in connection with export trade, and there is a measure of analogy in existing pure-food legislation. The present proposal, however, is not a police measure, but, on the contrary, a facility offered by the Government to those who choose to use it without any compulsion whatever.

• It is analogous to the fixing of grain standards by Government authority. The official grading of grain permits a precision in handling grain through all domestic and foreign commercial transactions that is now indispensable. It is no more difficult, to say the least, to provide a standard certificate for manufactured articles than it is for grain.

It will be evident that such a certification would provide authoritative knowledge to all buyers concerning the materials bought. The Government to-day has means, by analysis, of determining accurately the facts respecting the articles it buys, and many large business houses have similar facilities for their own use. The ordinary buyer, however, whether in connection with business or personal purchases, is denied accurate knowledge. No means are readily open to him to determine the quality of the goods he purchases, and the tendency of competition is often toward a reduction of quality as well as price. The fact, of course, is that the individual buyer to-day must purchase on appearances or upon the interested assurances of the seller rather than upon any true knowledge of what it is that he is buying. An enormous saving is possible if by the means suggested we can all of us come to buy on the basis of ascertained and known quality.

The suggestion made is very far-reaching. It contains no element of monopoly. Any manufacturer, large or small, could obtain a like certificate of standard quality if he produced the goods. The public would quickly learn what the certificate meant, and it would lead promptly and directly toward the improvement, as well as the maintenance, of the quality of goods.

The plan would be useful, also, in the extension of our foreign trade. The lack of confidence in goods bought in a distant

country is one of the barriers to free commercial intercourse. By the proposed certificates a foreign buyer would be assured that an order placed in the United States for standard goods would reach him under a certificate from the United States Government as to quality and that the power of our Government would be strongly exerted to prevent and to punish any deviation from standards. The proposed step would, at a single bound, put us in a commanding moral position in our foreign trade.

The suggestion made is not original with the Department, but was brought before it for consideration by persons experienced in domestic and foreign trade and in large financial operations. I do not hesitate to urge that the course suggested be adopted.

BUREAU OF THE CENSUS.

(SAM. L. ROGERS, *Director.*)

During the fiscal year this Service completed for publication the final reports of the last quinquennial census of manufactures; carried on its decennial canvasses of water transportation and shipbuilding and of religious bodies, its quinquennial canvass of electrical industries, and its special canvass of marriage and divorce; prepared and published the Official Register of the United States; conducted its annual inquiries relating to births, deaths, States, and municipalities; published quarterly statistics of stocks of leaf tobacco; made semimonthly and monthly collections and publications of statistics on cotton, cotton seed, and cottonseed products; completed reports on Negroes, deaf-mutes, and prisoners and juvenile delinquents, and a statistical directory of State institutions for the dependent, defective, and delinquent classes; took a special census of the Virgin Islands; inaugurated the publication of weekly mortality reports for certain large cities; performed much war work for other governmental establishments; carried on preparations for the Fourteenth (1920) Decennial Census; and complied with numerous requests for information.

The work done during the fiscal year and since its close along the above lines is described below.

CURRENT AND COMPLETED WORK ON STATUTORY INQUIRIES.

Census of Manufactures.

The reports of the last quinquennial census of manufactures, taken as of December 31, 1914, were finished early in the fiscal year, except some detail work in verifying proof.

Many of the bulletins which present the final reports of this census of manufactures were sent to the printer earlier than heretofore.

Census of Transportation by Water.

The field work on this decennial inquiry, which was made as of December 31, 1916, began in March, 1917, and was completed

in October of that year. Through cooperation with other services the work went faster than hitherto and cost less. Much of the data was collected by mail, and in some cases by telegraph. About half the owners or operators of craft covered by the census were canvassed in this manner before the field force went out. This census covered also the operations of fishing vessels; the last one did not.

A preliminary report, comprising two tables with descriptive text, was prepared late in January, 1918, and released for the press February 6. The tables and text for the final report are completed and will be sent to the printer soon.

Census of Shipbuilding.

This census was taken in conjunction with the water-transportation inquiry and for the same date (Dec. 31, 1916). A large part of the reports was obtained by mail, thus reducing the cost. Statistics for the shipbuilding industry for the year 1914, secured at the last census of manufactures, are included in the report. For military reasons this report has not yet been published, but the statistics compiled have enabled the Census Bureau to furnish valuable information of a confidential nature to various war boards.

Census of Electrical Industries.

This quinquennial inquiry, covering central electric light and power stations, street and electric railways, telephones and telegraphs, and municipal electric fire-alarm and police-patrol signaling systems, is proceeding as of December 31, 1917. The data have been collected so far as possible through correspondence. The field canvass by employees detailed from the office began April 9, 1918, in Omaha, Nebr., and was substantially completed in October, 1918. Compilation of the reports is under way.

Vital Statistics.

The "death-registration area," comprising those States and cities having adequate death-registration systems, has grown until it now embraces 29 States, the Territory of Hawaii, the District of Columbia, and 34 cities in nonregistration States, and contains approximately 76 per cent of the country's population.

The annual mortality report for the calendar year 1916 was completed and the proof returned to the printer during the fiscal year 1918. In order that the more important mortality statistics

for 1917 may be in the hands of the public at the earliest possible date, a bulletin presenting, with little text discussion, certain basic tables to be later included in the final report will be sent to the printer by the close of 1918.

The "birth-registration area" has grown rapidly during recent years; it now embraces 20 States and the District of Columbia, with a population representing about 53 per cent of the aggregate for the United States.

On October 6, 1917, the Census Service began publishing a "Weekly Health Index," giving mortality reports from about 50 of our largest cities.

Financial Statistics of Cities.

The report presenting financial statistics of cities with over 30,000 inhabitants, for the fiscal year 1917, was completed and sent to printer in January, 1918, within less than seven months from the close of the period covered. The report presents detailed statistics of revenues, expenditures, value of municipal properties, municipal indebtedness, assessments, and taxation; and also gives certain data relating to governmental organizations.

General Statistics of Cities.

For the fiscal year 1917 the Bureau published two reports called "Specified Sources of Municipal Revenue" and "Statistics of Fire Departments." The first presents, for the 219 cities estimated to have more than 30,000 inhabitants, data in regard to certain methods of raising revenues, namely, deriving them from business taxes collected without the issue of licenses, as on gross earnings of insurance companies; from business taxes, other than on the liquor traffic, collected through the issue of licenses; from other license taxes; from special assessments for public improvements, as street paving, sidewalks, and sewer construction; and from assessments for other purposes, as for street cleaning and sprinkling.

This information was opportunely made available when cities were readjusting their revenue systems so as to distribute taxation more equitably in regard to their own needs and the war requirements of the National Government.

The report giving statistics of fire departments of cities estimated to have more than 30,000 inhabitants was sent to the printer in January, 1918.

A report on municipal markets, covering the fiscal year 1918, is now being prepared. This will show the extent of municipal activity in providing market facilities and the use made of these facilities. The field work will be completed in December, 1918, and copy will be sent the printer early in 1919.

Financial Statistics of States.

The report presenting financial statistics for the 48 States of the Union, covering the fiscal year 1917, was completed in April, 1918. This report is similar in scope to the municipal finance reports, the general classifications being the same; but data in regard to functions exercised by State governments not generally exercised by municipal governments are also given.

The report for 1918 will be completed early in 1919.

Cotton and Cotton Seed.

During the fiscal year the Census Service conducted its regular inquiries in regard to cotton and cotton seed. There were issued 10 reports relating to cotton ginned to specified dates during the ginning season; 12, published monthly during the year, relating to cotton consumed, imported, exported, and on hand and to active consuming cotton spindles; 12, published monthly during the year, relating to cotton seed received, crushed, and on hand and cottonseed products manufactured, shipped out, and on hand; an annual bulletin on cotton production and distribution for the season of 1916-17; and an annual pamphlet giving complete statistics of cotton ginned from the crop of 1917. This pamphlet was distributed in time to be of use in making comparisons between the crop of 1918 and earlier ones.

Stocks of Leaf Tobacco.

Four reports on leaf tobacco held by certain classes of manufacturers and dealers were published.

Bulletin 136, entitled "Statistics of Leaf Tobacco," which presents, in comparable form, the data collected at the several tobacco inquiries made since the inauguration of the work in October, 1912, together with certain data compiled by other governmental agencies, was distributed during the fiscal year. This bulletin, the first of its kind, was designed to assemble the statistics for the various phases of the tobacco industry published by several governmental bureaus and to present them in form for ready reference.

Work Pertaining to Special Classes of the Population.

The report on deaf-mutes was completed during the fiscal year, and has been published. This report was submitted in proof to various specialists in the subject and received high commendation from them.

The preparation of the report on Negroes was also completed, and the report published. This report is a compilation in one volume of all the census statistics pertaining to the Negro race which have been collected from 1790 to the present time.

The report on prisoners and juvenile delinquents was also completed and published.

Religious Bodies.

The collection of the data at the last decennial religious-bodies inquiry, which was made as of December 31, 1916, was completed in July, 1918. The work was done almost entirely through correspondence. Tabulation of the data has been in progress for some time. A preliminary announcement was issued on May 2, 1918.

This work has been delayed by the pressure of war work.

Official Register.

The July 1, 1917, edition of the Official Register of the United States, which consists mainly of a directory of Federal employees, showing name, designation, compensation, branch of service in which employed, etc., was prepared during the first half of the fiscal year.

WAR WORK.**Work Done by the Bureau for Other Governmental Establishments.**

During the fiscal year the Bureau of the Census performed a large volume of war work for the War Department and other Federal departments and establishments. A few of the more important instances of this cooperation are given below.

Census of materials and commodities for use of war agencies.—In February, 1918, at the suggestion of the Director of the Census, I offered to utilize, in aid of the statistical work of the various war agencies, the services of as many as 100 experienced Census employees for six months. This offer was accepted by a number of the war agencies—the War Trade Board, the War Industries Board, the United States Shipping Board, the United States Food

Administration, the Council of National Defense, and the Commercial Economy Board—and on April 8 the work was given specific authorization and approval by you.

The war agencies wished statistics compiled showing the consumption and stocks on hand of certain raw materials used in war industries; also the production and stocks on hand of certain commodities made therefrom. This information was most urgently needed for iron and steel; wool machinery and woolen manufactures; kapok fiber, jute, and silk; leather stocks; boots, shoes, and manufactured leather goods; antimony; and graphite crucibles. Questionnaires or schedules were prepared and mailed as rapidly as possible; reports—monthly in some cases—on all the materials and commodities named have been prepared and transmitted to the war agencies; and work is in progress on other materials and commodities for which statistics have been requested.

In preparing this inquiry a survey of the existing sources of statistics of supply, production, and consumption of materials and commodities was made to ascertain what data were being collected by other governmental agencies, the purpose being to prevent duplication of statistical work. Some duplication was discovered and eliminated. This survey will continue with a broader scope during the war by the Statistical Clearing House, organized in connection with the War Industries Board.

It is my opinion that the usefulness of the Bureau of the Census would be materially enhanced if the scope of its work were extended by law so as to make the Bureau the clearing house for all the statistical information issued by the executive branch of the Federal Government. This could be done by having the executive departments and independent Government establishments submit reports monthly or quarterly to the Bureau of the Census describing all statistical data compiled or published during such period. This would enable the Bureau to detect any duplication or overlapping existing in the statistical work of the Government and recommend its elimination. It would make Federal statistics more easily available to the public and to persons engaged in research work and would bring about material economy.

Census of commercial greenhouses.—For the use of the priorities division of the War Industries Board the Bureau gathered data pertaining to commercial greenhouses, covering for the year ending June 30, 1918, area; value of products; fuel, fertilizers, insecticides, and fungicides used; and number of males 18 years of age and over continuously employed.

Censuses of nitric acid and of acids and materials used in the manufacture of explosives.—In September, 1917, at the request of the Committee on Chemicals of the Council of National Defense, the Acting Secretary of Commerce authorized the Director of the Census to take a census of the production and capacity of plants engaged in the manufacture of nitric acid; also a census of production and capacity of establishments manufacturing sulphuric acid and materials used in making acids and explosives, and the distribution of these commodities, which include cannon powder, mobile artillery powder, small-arms powder, trinitrotoluol, picric acid, ammonium nitrate, and military guncotton. The necessary blanks, together with the lists of manufacturers to whom they were to be sent, were prepared in collaboration with the Committee on Chemicals. The blanks were mailed and the reports received, checked, and acknowledged by the Bureau of the Census, which then transmitted them to the Committee on Chemicals for tabulation. The portion of the work assigned to the Bureau of the Census was completed in November, 1917.

Production of dental gold.—At the request of the Federal Reserve Board, I directed the Bureau of the Census to make a canvass of the production of dental gold. The statistics derived were submitted to the Federal Reserve Board.

Classification of occupations of registrants for Provost Marshal General's Office, War Department.—This work was undertaken, at the urgent request of the Provost Marshal General, on December 21, 1917, that a detachment of skilled workers from the Bureau of the Census be sent to the War Department to train the clerks of that department to prepare an industrial index of the registrants under the selective-service act. The preparation of this index consisted in the classification, according to occupational skill or experience shown, of cards prepared by the local registration boards from questionnaires filled by registrants. The Census scheme of classification of occupations was used.

Preparatory work began in late December, but it was not until the middle of February that the number of cards received at the War Department became sufficiently large to make it feasible to begin the actual classification. From that time until July 1, 1918, a period of four and one-half months, 30 experienced Census employees were occupied, under the direction of our chief statistician for population, in supervising and guiding the work of about 250 clerks employed by the War Department.

The number of cards received to June 30, 1918, and classified under the direction of the expert Census force was 8,147,034. This work was in some respects complex and could not have been successfully handled by inexperienced employees. The skill and energy displayed by the Census force were greatly appreciated by the Provost Marshal General, who, in a letter dated June 26, 1918, to the Director of the Census, paid a high tribute to the value of the service rendered.

Estimates of registrants for Provost Marshal General.—In May, 1917, immediately following the passage of the selective-service law, the Bureau of the Census published an estimate of the number of men 21 to 30 years of age, both inclusive, in the United States. This estimate showed a total of 10,077,700. The actual number of registrants on June 5, 1917, was 9,691,344, which, plus approximately 400,000, the number of men of those ages who were already in the military and naval services, and therefore not required to register, brought the total very close to the Bureau's estimate.

On June 12, 1918, at the request of the Provost Marshal General, the Bureau estimated a total of 1,011,589 men, for the United States as a whole, who had become 21 years of age during the 12 months ended June 5, 1918. The actual number of registrants on June 5, 1918, plus the number of enlistments of men 21 years of age, amounted to 953,453; but the greater part of the difference of 58,136 between this number and the Census Bureau's estimate is accounted for by a decrease of 45,098 in the number of aliens subject to registration.

On July 30, 1918, at the request of the Provost Marshal General, the Bureau estimated a total of 13,194,408 men in the United States on July 1, 1918, of the ages from 18 to 20, inclusive, and from 32 to 45, inclusive. Deducting from this number 400,000 already in service, approximately 12,800,000 were estimated to be subject to registration. The actual registration on September 12 of 12,870,000 again confirmed the accuracy of the Bureau's estimates.

Determination of ages of registrants.—Much work was done during the fiscal year in connection with the furnishing of transcripts of ages of persons who did not register under the selective-service law, but who were believed to be within the specified age limits. These transcripts were supplied to the Department of Justice, to local registration boards, and to the individuals concerned. The Bureau has been advised by county officials that as

soon as it became generally known that they had access to Census information in regard to ages many men voluntarily registered.

The recent extension of the draft ages has caused a great increase in this work.

Allocation of enlistments for the Office of the Provost Marshal General.—The 117,974 men who enlisted in the Regular Army from April 2 to June 30, 1917, inclusive, represented a portion of the credits to be applied to the gross quotas of the States, the counties, and the cities of 30,000 population and over in the apportionment of the first draft. At the request of the Provost Marshal General these enlistments were allocated by the Bureau of the Census. Enlistments in the Navy, the Naval Reserve, the Naval Volunteers, and the Marine Corps from April 2, 1917, to June 30, 1918, which numbered 293,788, were similarly allocated.

In a letter dated August 17, 1918, to the Director of the Census, the Provost Marshal General expressed his keen appreciation of the thorough manner in which the work was done.

Work for the United States Fuel Administration.—For the Fuel Administration the Bureau compiled data showing the kinds and quantities of coal consumed by establishments using 100 tons or more per annum and whether such establishments generated electricity for power.

Work for Railroad Wage Commission—During the months of February and March, 1918, the Census Bureau prepared a large number of tables for the Railroad Wage Commission for use in the adjustment of the wages of railroad employees by the Federal Railroad Administration.

Miscellaneous war work.—In addition to the above, the Census Bureau has performed war work for the American National Red Cross; the Treasury Department; the Department of Justice; the Council of National Defense; the Housing Committee; the United States Shipping Board; the Emergency Fleet Corporation; the Medical Corps, War Department; the Federal Trade Commission; the Federal Reserve Board; the United States Geological Survey; the Joint Information Board on Minerals and Derivatives; the Tanners' Council; the National Committee on Prisons and Prison Labor (through the Bureau of Foreign and Domestic Commerce); the Bureau of Education; the War Industries Board; the United States Food Administration; the Board of Arbitration, New York Harbor Wage Adjustment; and the Port Facilities Commission.

Members of force enlisted and drafted into military and naval services.—During the fiscal year 47 members of the Census force, including 14 local cotton agents, entered the military and naval services; and from the entrance of the United States into the war until September 15, 1918, 64 members of the force, including 20 cotton agents, entered those services. No request was made to obtain deferred classification because of their Census employment.

SPECIAL AND MISCELLANEOUS LINES OF WORK.

Marriage and Divorce.

Marriage and divorce statistics for the calendar year 1916 have been collected and are being compiled.

The canvass has been conducted almost entirely by correspondence. Complete statistics as to divorce were secured at the State capitals of Nebraska, New Jersey, and Wisconsin; and for the remaining States and the District of Columbia the information was obtained through the offices of the county and court clerks. In the case of the marriage statistics the information for 27 States was obtained from the State capitals or from printed reports; and for the remaining States the data were obtained through the county or court clerks or officials having custody of the marriage records.

The tabulations had been in progress for some time prior to the termination of the canvass and were completed at about the same time.

Census of the Virgin Islands.

At the request of the Secretary of the Navy, the Director of the Census was instructed, on October 1, 1917, to take a census of the Virgin Islands. This census covered population, agriculture, manufactures, fisheries, and wages and hours of labor as of November 1, 1917. The work was done under the supervision of the chief statistician for manufactures, assisted by six employees of the Department, but the actual enumeration was done chiefly by local employees. This work began on December 24, 1917, and was completed on January 12, 1918. The final proof of the report was returned to the Government Printing Office, approved for printing, on July 9, 1918, and printed copies were delivered to the Department August 25.

United States Life Tables.

In June, 1916, the Bureau of the Census compiled and published a series of "life tables" based on the population in 1910 and the mortality in the three years 1909, 1910, and 1911 for certain States and the District of Columbia. The preparation of a similar series of tables exhibiting mortality conditions in 1890 and 1901 and during the decennium 1901 to 1910, inclusive, has been nearly completed, and copy will be sent to the printer before the close of 1918.

This work has been made subsidiary to the regular work of the Bureau, and it has therefore not been possible to complete and publish the results sooner. Their value, however, is permanent and will not be impaired by the delay.

Statistical Directory of State Institutions.

During the fiscal year the Bureau completed the compilation of a statistical directory of State institutions for the dependent, defective, and delinquent classes. The classes of institutions covered include State prisons and penitentiaries and State institutions for the insane, feeble-minded, epileptic, tuberculous, blind, deaf, and dependent.

Searching of Census Records to Determine Ages.

During the fiscal year 5,043 searches were made of Census records to determine ages of pensioners.

Tabulation of Data for Disputed Areas of Europe and Africa.

In the latter part of the fiscal year the Bureau, upon my authorization, began the tabulation of data covering the disputed areas of Europe and Africa; that is, those areas whose final disposition will be determined by the outcome of the war. These data are obtained from foreign census reports, statistical yearbooks, official trade reports, and such other sources as are available.

PREPARATIONS FOR THE FOURTEENTH CENSUS.

Both my annual report for 1917 and that of the Director of the Census set forth the urgent need of making adequate preparations for the Fourteenth Census and outlined briefly the preparatory work which had already been done. A careful and detailed study of the act providing for the Thirteenth and subsequent decennial censuses was made, with a view to determining what amendments or changes were needed to meet the conditions under

which the Fourteenth Census will be taken. After thorough consideration it was decided to recommend to Congress the enactment of an entirely new act, differing from the Thirteenth Census act in many details, but containing no radical changes. Such a bill was drafted and submitted to the House Committee on the Census, which held a series of hearings upon it from February 20 to April 10, 1918. After the Director and other Census officials had been heard, the Secretary of Agriculture, representatives of the Bureau of Mines, the Geological Survey, the Food Administration, and myself were called upon to express our views. On July 2, 1918, the bill passed the House with a few amendments of a minor character and is now pending in the Senate.

I can not too strongly emphasize the importance of promptly enacting this bill into law. If further action upon it is deferred until the next session of Congress, there is a possibility that it may not be passed at all by the present Congress on account of lack of time. If this were the case, the Census Bureau would find itself at the beginning of the Fourteenth Census period (July 1, 1919) without the full and definite knowledge of legal authority and requirements under which to perform the great task of inventorying the population and industries of the United States. In certain vital respects the Bureau can not plan intelligently for the coming census until it knows exactly what these legal requirements are to be.

Such preparations for the coming census as are possible have been continued, and everything that can be done under the present conditions is being done.

MECHANICAL EQUIPMENT.

Work in Mechanical Laboratory.

In addition to the maintenance of tabulating machinery for current use in the Census Bureau and the Bureau of Immigration, the Mechanical Laboratory was engaged in overhauling and constructing machinery for the tabulation of the Fourteenth Census reports. The new automatic tabulating machine, completed toward the close of the fiscal year 1917, was given a practical test in connection with the work of tabulating mortality data and was found to be entirely satisfactory and a marked improvement over the machine used at the Thirteenth Census.

The present plans call for the completion of all parts entering into the construction of the Fourteenth Census tabulating equipment *before* the expiration of the present fiscal year.

Integrating Counter.

In a former report I referred to beginning work on the development of an "integrating counter"—that is, a counter which will record and add numbers, instead of mere units, thus performing automatically the work done by the operator of an adding machine—for use in tabulating certain classes of the census data, such as those pertaining to agriculture and manufactures. This work was begun on July 6, 1917, and has shown satisfactory progress to date. The idea of the first model integrating counter has been developed and all drawings made, the patent situation has been carefully studied, and patterns, castings, and practically all parts are ready for assembling. The most difficult features of the work have been completed, and the preliminary tests show satisfactory results.

OFFICE FORCE.

The appropriation act for the current fiscal year provided for 609 permanent officials and employees of the Census Bureau, representing an increase of 46 over last year. At the same time the numbers of positions in the various salary classes have been readjusted so as to provide a somewhat better average salary scale than heretofore. This readjustment will, it is hoped, diminish the tendency of the census force to seek employment elsewhere, although the salary scale is still unduly low as compared with those existing in other branches of the Government.

The greatest difficulty which the Bureau now experiences is in inducing eligibles on the civil service registers to accept employment at the entrance salary of \$900. During the 14 months' period from July 1, 1917, to August 31, 1918, inclusive, offers of appointment were tendered to 569 eligibles on the registers of the Civil Service Commission. Of these eligibles 299 declined, 79 failed to reply, and 191 accepted appointment.

OFFICE ROOM AND STORAGE SPACE.

The beginning of the Fourteenth Census period (July 1, 1919) is now less than a year distant, and the matter of providing adequate office accommodations during that period, as well as proper storage space for its permanent records, is one of importance and urgency.

During the Thirteenth Census period (1909-1912) the total floor space occupied was approximately 200,000 square feet; with this as a basis, and taking into account the growth and

change in the country's population and industries in 10 years, it is estimated that during the next decennial census period the Bureau will need about 275,000 square feet of space, including storage. Since the total floor space occupied in the Commerce Building on June 30, 1918, amounted to only 78,386 square feet, of which about 8,000 square feet is storage space, and as there is no more available room in the Commerce Building, the necessity of finding other quarters for the greatly increased census force (between six and seven times the Bureau's present force) during the Fourteenth Census period is apparent. If the war shall have ended before it is necessary to expand the Bureau's force for the decennial census, it may be possible to accommodate the extra force in some of the temporary buildings erected for the use of the military departments and for the various special war agencies. In order that preparations may be made for sending out the enormous quantities of schedules and other supplies to the supervisors in charge of the field work a reasonable time in advance of January 1, 1920, the date as of which it is proposed to make the enumeration, it will be necessary for part of the enlarged census force to begin work several months in advance of that time—perhaps in September or October, 1919.

BUREAU OF FISHERIES.

(Dr. HUGH M. SMITH, *Commissioner.*)

This service has continued its efforts to meet the peculiar conditions and obligations imposed by war. Its operations, while thus in a measure restricted, have in other essential respects assumed a scope and importance never before attained.

The steamers *Albatross*, *Fish Hawk*, *Halcyon*, and *Phalarope*, of the Fisheries Service, have been during the war under the direct control of the Navy and in active use. The *Halcyon* was new and the *Fish Hawk* had received extensive repairs, including new engines, when turned over to the Naval Service. The entire plant at the marine biological station at Beaufort, N. C., has been taken over by the Navy Department, and the buildings of the marine hatchery and biological station at Woods Hole, Mass., have been largely and continuously utilized as headquarters of a naval reserve force and by the American Red Cross and the Y. M. C. A.

Propagation of Food Fishes.

No new fish hatcheries were constructed during the fiscal year. The regular hatcheries operated numbered 40, together with 36 auxiliaries and 66 egg-collecting stations. The stations at Havre de Grace, Md., and San Marcos, Tex., remained closed during the year for reasons fully set forth on pages 159-163 of my last annual report. The Texas Legislature, however, at its last session enacted a law that complies with the stipulations imposed by Congress, and we were glad to reopen the San Marcos hatchery on July 1, 1918.

The aggregate output of the fish hatcheries was somewhat in excess of 4,000,000,000, as against a little over 5,150,000,000 in 1917. The decrease, which was largely in pike perch, cod, and pollock, was principally due to unfavorable weather conditions during the egg-collecting seasons. Noteworthy advances were made in the hatching and planting of the Pacific salmon, whitefish, and winter flounder. About 90 per cent of the work of the hatcheries is devoted to the maintenance of species that support commercial fisheries.

An important feature of the fish-cultural operations is the increasingly large percentage of fish reared to fingerling or yearling age before being planted. In the fiscal year 1917 the number of such fish was about 82,115,000, while in 1918 the number rose to 168,965,000, an increase of more than 100 per cent. Especially significant is the outcome of the policy of rearing the Pacific salmon to the fingerling and the yearling stages. The Bureau is striving to plant the entire output of the Pacific salmon hatcheries at such an advanced age that the losses to which the young are liable may be minimized. The hatcheries are being adapted to this end, and the problem of providing sufficient and proper food at minimum cost is gradually being solved for the different communities and species. Genuine progress in this vitally important field and practice of fish culture is being made; and although the superior results are achieved at increased expense, it has not yet been necessary to appeal to Congress for a special appropriation.

In the distribution of the output of the hatcheries, the Bureau's special cars traveled 102,330 miles, of which 10,024 miles were free transportation granted by the railroads. Messengers with detached shipments of fish traveled 468,244 miles, of which 54,578 miles were free. Plantings were made in every State and Territory, and the cars were hauled on 47 railroads and the messenger shipments on 190 railroads. The readjustment of rates charged for the distribution of fish is now under consideration by the United States Railroad Administration, and a material advance in cost may be necessary that this service may be rendered without actual loss to the railroads.

Record Work in Rescuing Stranded Food Fishes.

The systematic work done each season in salvaging food fishes left stranded when the flood waters of the Mississippi River and its tributaries subside has attained during the fiscal year large proportions, completely eclipsing the best former records. Specially equipped seining parties have operated from Minnesota to Mississippi, and a field station established at Cairo, Ill., covers both the Illinois and Kentucky sides of the Ohio River, and has been productive. The number of food fishes rescued from landlocked ponds, sloughs, and pools between July 1 and October 21, 1918, in each of the fields of operation was as follows:

Homer field.....	24, 583, 045
La Crosse field.....	5, 392, 840
North McGregor field.....	4, 848, 575

Bellevue field.....	8, 751, 655
Meredosia field.....	1, 218, 415
Cairo field.....	1, 571, 100
Friar Point field.....	253, 180
Total.....	46, 618, 810

As all of these fish would have perished by the drying or freezing of the temporary waters in which they had been caught, the importance of this rescue work is evident. *The cash value of the fish saved, at the rates charged by commercial hatcheries, exceeds the total appropriation of the Bureau for the fish-cultural service.*

Increasing the Consumption of Fish.

The Bureau has been more active and successful than in any previous year in bringing to the attention of the consuming public the merits and availability of fish as food and in indicating sources of supply for the demand thus created.

The work has assumed different aspects in particular localities, but its general purpose has been to induce the American public to rely on fish as a staple food, to overcome unsound prejudice, and to avoid waste in the utilization of aquatic creatures. Because of the economic situation caused by war, these activities have a more direct appeal than ever before.

Aid in developing markets for wholly or partly neglected aquatic food products has been given in the case of the sea herring of Alaska, gizzard shad, river herrings, menhaden, bowfin, burbot, carp, eulachon, grayfishes, sharks, skates, rays, jewfish, drum, redfish, robalo, rockfishes, sablefish, sea catfishes, sea robins, crevalles, and tarpon; such mammals as whales, porpoises, and dolphins; and such by-products as roe and milt of various fishes. In order to do this, it has been necessary to conduct a systematic advertising and educational campaign in the various communities, employing for this purpose persons experienced in the fish trade and in the preparation of foods for the table. One branch of this campaign has been practical field work in the Middle West having for its object the establishment of a regular market for common fishes from the coast of the Gulf of Mexico, which can be supplied in abundance when the interior markets contain little or no fresh fish at a reasonable price. In cooperation with the Department of Agriculture and the Food Administration, the Bureau has instituted in various cities not heretofore supplied a trade in carload lots of cheap, wholesome fishes taken on the west coast of Florida.

The food value of the menhaden has been brought to public attention. This fish, one of the most abundant on the Atlantic seaboard, is caught chiefly for conversion into oil and fertilizer, although the experiments of the Bureau show that it is a wholesome food in a fresh, salted, smoked, or canned condition. Inasmuch as more than 1,000,000,000 menhaden have been caught by our fishermen in a single year (about 600,000,000 pounds), the possibilities of this fish as food are evident. Larger quantities of menhaden are now being offered for sale in the eastern markets, and there is reason to believe that the consumption will increase to a point that will make the menhaden in reality, what it is in potentiality, one of the most important of American food fishes.

In connection with the "eat more fish" campaign, the Bureau has, by means of demonstrations, exhibits, correspondence, and printed matter, advocated and encouraged the home canning of fish by simple processes within the resources of every housewife and the use of pressure cookers for softening the bones of fishes. Fish bones contain an essential food constituent, lime salts, which can not be so conveniently or economically obtained otherwise. It is therefore important to utilize this and the other valuable salts occurring in fish bones.

Development of Aquatic Sources of Leather.

Throughout the year the Bureau has continued its effective cooperation with tanners, fishermen, and others interested in the development of new sources of leather from the skins of aquatic animals. Among the advances to be noted are the designing of special types of nets adapted for catching sharks; the devising of means for quickly removing skins from sharks and similar fishes with reference to the needs of the tanner; progress in methods suitable for tanning the skins of smaller fishes on a commercial scale; arrangements by tanners to engage in the fish-leather industry and establishment of connections with fishing centers to secure supplies of raw materials; establishment of small plants at various coastal points where sharks will be caught, their hides tanned, their flesh prepared for food, their oil extracted for industrial purposes, and their refuse converted into fertilizer; experiments with leathers made from fishskins to determine their special fitness for shoes and other purposes; and expediting of shipments of raw skins from producers to tanners. Through cooperation with the Bureau of Standards, the services of a

technically trained tanner were secured for experimental work at a large tannery; the expert, however, in a short time entered the military service, and the results secured were due largely to the interest of the tanning company. The largest and most available source of fishskins is the shark family. The experiments showed that shark leathers may be very satisfactorily used for shoes, linings, etc., and as cordovan. The average tensile strength of two skins submitted to the Bureau was 3,905 and 4,742 pounds per square inch.

The outlook for this new branch of industry is promising. Shortage of labor, transportation difficulties, and other drawbacks have retarded progress; but the creation of special fisheries for fish hides and the definite movement of raw materials in noteworthy quantities from fishermen to tanneries at prices mutually satisfactory indicate that the business has become well established.

A Fishery-Products Laboratory.

For years the Bureau has suffered for lack of facilities for practical demonstrations and experimentation in the methods of preparing and preserving fishery products. The fishery industries, particularly those concerned in canning and otherwise preserving food products, labor under the serious drawback of ignorance of the scientific principles underlying their operations. There is also an underconsumption of fish, due in part to the inferior quality of much that is placed on the market and in part to the ignorance of the consumer regarding the dietetic qualities and peculiarities of the several species, with consequent improper preparation for the table. As a result there is an annual loss of hundreds of millions of pounds of valuable fish food. With adequate equipment and personnel provided, the Bureau has held that it could render effective aid in developing methods for overcoming such difficulties, and that important results could be achieved in some fields within a short time.

You have approved and authorized an allotment of \$125,000 from the fund for national security and defense for a laboratory and its equipment for the conduct of work of this character and for a temporary personnel. This is being pushed vigorously, and investigations have begun which will yield important results in making available larger quantities of fish for food and in educating the public to the merits of the various fishery products.

Administration of Alaskan Fisheries.

The fisheries of Alaska have been administered in pursuance of the authority and facilities granted by Congress. The laws and regulations for the protection and conservation of the fisheries have been enforced by a corps of agents and wardens; private salmon hatcheries have been inspected; streams have been opened or improved for the passage of salmon by the removal of obstructions; a census of red salmon entering Wood River, a stream closed to commercial fishing, has been taken as heretofore; following public hearings, orders have been promulgated suspending or restricting fishing in salmon streams where circumstances demanded such action; salmon-cultural operations have been conducted on a large scale; special investigations of salmon and salmon streams have been instituted; the further development of the fishing industry has been aided by demonstrations and experiments looking to the fuller utilization of the water resources of the Territory, particularly those that have been partly or wholly neglected; and detailed statistics of the industry have been collected and compiled.

The fisheries of Alaska in 1917 attained a higher development and yielded larger returns than in any previous year. The number of persons engaged in all branches of the industry was 29,491, an increase of 5,497 over 1916; the capital invested was \$54,937,549, an increase of \$15,367,937; and the value of the products as placed on the market was \$51,466,980, an increase of \$25,310,421. The greatly augmented value of the fisheries was due partly to an increased output and partly to a marked advance in the price of canned salmon, ranging from 56 per cent for red salmon to 94 per cent for king salmon.

The salmon industry surpassed all previous records in both size and value of the pack. The canned output reached the astonishing total of 5,947,286 cases of 48 one-pound cans, and had a market value of \$46,304,000, about two-fifths the quantity and one-half the value representing red salmon.

In view of obsolete and inadequate features of the present fishery laws, it is earnestly hoped that the comprehensive bill favorably reported by the House Committee on the Merchant Marine and Fisheries may soon be enacted into law.

Alaska Fur-Seal Industry.

Under the provisions of the act of Congress approved August 24, 1912, giving effect to the North Pacific Sealing Convention of

July 7, 1911, the five-year close time on land killing expired on August 24, 1917; and the taking of fur seals for commercial purposes, as distinguished from the inconsiderable requirements of the natives of the Pribilof Islands, then became lawful. Inasmuch as the regular sealing season properly closes about August 10, owing to the supervention of the so-called "stagy" condition of the fur, only a small number of skins was taken in the calendar year 1917. For 1918 the number of seals that might be secured was tentatively fixed at 25,000, which limit was increased to 35,000, after the season had begun, on the recommendation of the responsible representatives of the Department on the islands. Up to August 10 the number of skins taken was 33,881, of which 26,881 were from St. Paul Island and 7,000 from St. George Island. The skins were mostly from seals 3, 4, and 5 years of age. The requirement of law that in 1918 there should be set aside for breeding purposes 5,000 male seals 3 years of age was met by reserving more than 9,000 seals of that age.

On account of greatly increased sealing operations in 1918, it was considered necessary to provide additional assistance for taking, handling, and curing the skins. Eleven natives were hired for the purpose at Unalaska and five experienced men were sent from Funsten Bros. & Co., of St. Louis, the contractors for dressing the skins. The handling of the augmented business incident to the taking and preparing of the island products has been much facilitated by the introduction (in the spring of 1918) of three motor trucks, used in road building, in making the remoter hauling grounds more accessible, in hauling wood and supplies, and in other ways for the benefit of the natives and the expedition of Government business.

Still further assistance to the proper administration of the Pribilof Islands affairs was afforded by Congress in appropriating \$20,000 for a wooden power lighter for use in handling products of and supplies for the islands and in making trips between the islands and to Unalaska.

Census of Alaska Seal Herd.

The 1917 census of seals at the Pribilof Islands gave, as the total strength of the herd on August 10, 1917, 468,692 animals of all ages. The census of 1918, taken under the same auspices and in the same manner, showed an approximate number of 496,611 seals of all ages on August 10, 1918, in addition to the 33,881 taken for commercial purposes during the year. The different elements of

the herd in 1918, as enumerated and computed by G. Dallas Hanna, the agent of the Department who has supervised the census for a number of years, were as follows: Breeding cows, 143,005; new-born pups, 143,005; yearlings, 83,203; 2-year-olds, 60,564; 3-year-old males, 9,117; harem bulls, 5,344; males 4, 5, and 6 years old, 32,810; idle and surplus bulls, 19,553; average harem, 26.76.

Revenue from Pribilof Islands Products.

During the fiscal year 1918 there were two sales of sealskins, one of fox skins, and two sales of seal bones from the Pribilof Islands.

The sealskins numbered 9,339 and were dyed, dressed, and machined before being sold at public auction in St. Louis. The gross proceeds were \$379,392; the expenses, including cost of preparation of skins, discount for cash, agents' commission, transportation, etc., aggregated \$115,357.29; net proceeds, \$264,034.71.

The fox skins sold at public auction in St. Louis numbered 567 blue and 39 white pelts. The gross receipts were \$35,680.50 the expenses \$4,909.20, the net proceeds \$30,771.30.

Old seal bones, aggregating about 200,000 pounds, collected by the natives during the year, ground, bagged, and delivered at Seattle, were there sold for \$2,742.70, from which sum there was deducted \$1,319.86, payments made to the natives and a few minor expenses, making the net proceeds \$1,422.84. Further lots of bones were collected but not sold during the year.

All of the above products were transported on the steamer *Roosevelt*. The net proceeds, amounting to \$296,228.85, were covered into the United States Treasury.

The arrangements made with Messrs. Funsten Bros. & Co., of St. Louis, for the handling of seal and fox skins have continued to be advantageous to the Government and to the American fur trade. Special importance is attached to the dressing and dyeing of fur sealskins before they are sold, as they thus become immediately available to a much larger number of furriers.

With the publication of Messrs. Funsten Bros. & Co.'s catalogue announcing the sale of Government sealskins on April 22, 1918, there was formally adopted a new classification of such skins. The terms theretofore employed in the trade represented the fortuitous outgrowth of about a hundred years, and were misleading. The new terms avoid the faults of the old usage and have been adopted in conformity with the general practice of the fur trade;

they are applied arbitrarily with reference to certain specified size limits of skins.

A By-Products Plant for Pribilof Islands.

Since the beginning of the sealing industry on the Pribilof Islands, most of the carcasses have been wasted—thrown away. Small quantities of meat and fat have been consumed by the natives, but no use was made of the great bulk of the material, which, with the resumption of commercial killing, has value not to be neglected. The natives will continue to use small quantities of seal meat, and the fox herds will consume a certain amount, but there will remain a large quantity of material that should be converted into fertilizer and oil, for which there is an active demand.

On my recommendation, you made, on April 9, 1918, an allotment of \$25,000 from the fund for the national security and defense to enable the Bureau of Fisheries to erect on the Pribilof Islands a plant for utilizing the waste products of the sealing industry. The plant has been delivered at St. Paul Island, and construction and installation have proceeded so well that actual operations will begin during the autumn of 1918. It is expected that, with the demand for and prices of oil and fertilizer, this plant will more than pay for itself in the first year.

Minor Alaskan Fur-Bearing Animals.

The laws and regulations for the protection of the minor fur-bearing animals of Alaska have been enforced by a force of regular wardens, supplemented by special wardens employed by a reciprocal arrangement with the governor of Alaska.

The only change made in the regulations during the year was the extension of the close season on beaver until November 1, 1923. This action was taken on the recommendation of the local wardens, the governor of Alaska, and others. The beaver has increased in numbers as a result of the protection afforded by the Department, but the increase has been local rather than general; and the consensus of opinion among those having the best knowledge of the subject and the best interests of the Territory at heart was that it would be highly desirable to give this important fur bearer further protection for a period of five years.

Statistics of the furs from Alaska have been compiled as heretofore, through the cooperation of postmasters, customs collectors, shippers, and others. The figures for the year ending November

15, 1917, show a value of \$1,028,719, exclusive of the furs from the Pribilof Islands, and give an idea of the importance of the trapping industry. The leading fur bearers are blue, cross, red, silver-gray, and white foxes, lynx, mink, muskrat, and otter, the red fox and the lynx greatly predominating.

Personnel.

A serious curtailment of the Bureau's operations, particularly in its fish-cultural branch, arises from the extremely small compensation allowed by Congress for the lower grades. The matter has long been embarrassing; it has in the past few years become acute because of general industrial conditions. Now the Bureau finds it more and more difficult to obtain persons to fill statutory positions, or, having once secured them, to retain them. In consequence many of the lower positions at fish hatcheries have been vacant much of the time.

A step looking to correct this situation is the inclusion in the estimates of appropriations for 1920 of a provision for a readjustment of the salaries in the fish-cultural service.

97796°—COM 1918—8

BUREAU OF LIGHTHOUSES.

(GEORGE R. PUTNAM, *Commissioner.*)

This Service maintains aids to navigation on all coasts under the jurisdiction of the United States (except the Philippine Islands and Panama) and also on the principal lakes and rivers. It is charged with the maintenance of aids to navigation along 47,300 statute miles of coast line and river channel.

On June 30, 1918, there were 5,899 persons employed in the Lighthouse Service, including 120 technical force, 150 clerical force, and 5,094 employees connected with depots, lighthouses, and vessels.

During the fiscal year there was a net increase of 446 in the total number of aids maintained, the total at the end of the year being 15,673. Of these 5,545 are lights of all classes and 587 are fog signals. The total number of aids in Alaska, comprising lights, fog signals, buoys, and daymarks in commission at the close of the fiscal year, was 439, including 168 lighted aids. Special attention has been given to Alaska; 11 new lights were established there; 3 lights were changed from fixed to flashing; 1 gas and bell buoy, 13 unlighted buoys, and 5 beacons were established. It is expected that 16 other lights and 2 gas and bell buoys will be established during this season (summer of 1918). Special appropriations aggregating \$290,000 will be asked of Congress to continue the work of general increase of lights and buoys in Alaska, for a light and fog signal at Cape Spencer, Cross Sound, and for repairs and improvements at existing light stations.

The work in Alaska is of urgent importance. The coast line is of vast extent and of a most dangerous character. The value of one fine ship lost for lack of safeguards (and many are so lost) would go far to make navigation in those waters secure. The future of Alaska depends on the safety with which its waters can be navigated.

Improvements in aids to navigation in the Service generally have been made during the year as follows: Flashing or occulting lights were installed in place of fixed lights at 13 stations; incandescent oil-vapor lights were substituted for oil-wick lamps at 3

stations; acetylene or electric incandescent lights were substituted for other lights at 41 stations, including 2 light vessels and 10 buoys.

A new light station was established at Navassa Island, West Indies; the light went into commission October 21, 1917, and is on the highest point of the island in the passage between Haiti and Jamaica. It is a reinforced concrete tower, with the light 395 feet above the sea, showing a double white flash every 30 seconds, 47,000 candlepower, visible 27 miles, and is an important aid for vessels bound to and from the Panama Canal; it is greatly appreciated by master mariners on that route.

The systematic methods of improvement and the use of modern apparatus in increasing the number and brilliancy of aids have been of great value to the safety of commerce.

In accordance with the established custom of the Service effort has been continued to consult the needs of maritime interests and to cooperate effectively with other branches of the Government in related work. The most important work of cooperation has been that with the War and Navy Departments in accordance with law and Executive order. The Naval Appropriation act of August 29, 1916, authorized the President, whenever in his judgment a sufficient national emergency exists, to transfer to the service and jurisdiction of the Navy Department, or of the War Department, such vessels, equipment, stations, and personnel of the Lighthouse Service as he may deem to the best interest of the country; and also provided that the Secretary of the Navy, the Secretary of War, and the Secretary of Commerce shall jointly prescribe regulations governing the duties to be performed, etc. These regulations were issued April 11, 1917. By executive orders of the President 46 lighthouse tenders, 4 light vessels, and 21 light stations have been transferred to the Navy Department, including a total of 1,132 persons employed thereon. These vessels and stations have since that time performed various duties under the Navy, and have also continued the maintenance of the aids to navigation and other work necessary for the Lighthouse Service.

In addition to the officers and employees directly transferred, the superintendents of lighthouses and various other officers of the several lighthouse districts (46 persons) have reported to the Navy and Army authorities and have rendered service in coordinating the military and lighthouse duties of the transferred portions of the Lighthouse Service.

The duties performed by the transferred units directly for the military and naval authorities are, of course, matters pertaining to

those departments, but they consist principally of work on submarine nets and buoyage in connection therewith, patrol and watch service, drill in mine laying, etc. Prior to the war, for a number of years, a large proportion of the lighthouse tenders had been equipped by the War Department with mine-laying equipment and had periodic drills in this work.

The regular work of the Lighthouse Service—the maintenance of lighthouses, lightships, buoys, and beacons—is of extreme importance in war time to safeguard and expedite the movement of both merchant ships and naval vessels. This work has been increased rather than diminished by war-time demands and difficulties. The Lighthouse Service had prior to the war no surplus of vessels, equipment, or personnel beyond that necessary for the efficient maintenance of the existing establishment. The regulations under the law and Executive order providing for cooperation with the War and Navy Departments, therefore, contemplated the continuance of lighthouse work by the transferred units, and this has been done. By strenuous work on the part of the whole Service, and particularly the district and vessel officers, the vast system of aids to navigation is being kept up in addition to the extra duties assigned to vessels and men.

In addition to the work done by the tenders and other units transferred to the direct jurisdiction of military and naval officers, the Lighthouse Service cooperates in a number of other ways. At the General Lighthouse Depot, Staten Island, N. Y., facilities are provided for the establishment of a naval base, including large dock frontage for berthing vessels and a large amount of building space for barracks, storage, and offices; repairs are made at this depot to naval and quartermaster vessels, and buoys and other supplies are issued. Repairs are made and supplies furnished at other depots also. Numerous buoys and other aids have been placed, changed, or discontinued, to meet special needs, and buoys and moorings have been purchased for the War and Navy Departments. Keepers of important coast lighthouses and masters of light vessels are instructed to keep a lookout for submarines and other enemy activities, confidential publications from the Navy Department have been furnished them, and reports are promptly forwarded. There has been cooperation with the Navy and Treasury Departments in the improvement of coast communication facilities by telephone and radio, and a large number of lighthouses, light vessels, and tenders have been provided with such facilities, under various appropriations.

The following additional work has been performed: Various investigations have been made at the request of the Department of Justice and the military and naval information services. Officers of the Marine Engineering Division of the Lighthouse Service have assisted the Shipping Board in various matters respecting the design and sea trials of various types of vessels, including concrete vessels. An officer of the Lighthouse Service is engaged on the work of the chain section, War Industries Board, having to do with the standardization and allocation of iron and steel chain for the different activities of the Government. The Commissioner of Lighthouses is serving as the representative of the Department of Commerce on the New York Harbor Wage Adjustment Board. A scientific assistant in the Lighthouse Service has assisted a naval technical board.

Up to October 1, 1918, a total of 147 persons from the Lighthouse Service, in addition to those transferred by Executive order, had entered the Army or Navy, making with those transferred a grand total of 1,279 employees who have entered the military services, or 22 per cent of the normal force of the Lighthouse Service.

By a decision of the Bureau of War Risk Insurance the personnel of the Lighthouse Service transferred to the service and jurisdiction of the War and Navy Departments are within the terms of the War Risk Insurance act of October 6, 1917.

During the fiscal year 51 tenders and 67 light vessels were in commission. New vessels under construction are light vessels *No. 99* and *No. 103* for duty on the Great Lakes, and a working barge for use on the Hudson River has been practically completed.

On March 3, 1918, the Thirty-Five Foot Channel Light Vessel *No. 45, Va.*, was damaged by fire at the works of the Colonna Marine Railway Corporation, Norfolk, Va. The vessel was laid up for repairs when fire broke out on the ferryboat *Castleton*, and before the light vessel could get clear of the dock the ferryboat had drifted out and penned her in.

The schedules of pay established from time to time by the United States Shipping Board for officers and crews of vessels, while they do not apply directly to vessels of the Lighthouse Service, are considered standard wages in the localities in which they have been placed in effect, and it has been necessary to adjust the pay of complements of lighthouse vessels as far as appropriations admit, both in justice to employees and in order to keep up a proper efficiency. The wage scale for certain mem-

bers of deck and engine departments, announced by the Shipping Board on May 18, 1918, for vessels sailing from Atlantic and Gulf ports of the United States is now being paid to crews of lighthouse vessels, and licensed officers were granted increases to meet, as far as possible, new rates authorized in the month of June, 1918, by the Shipping Board for this class of persons. This action has necessitated large increases in the estimates for salaries on vessels of the Lighthouse Service, and estimate for additional increase will be submitted in order to bring the pay of officers of the vessels more nearly up to current rates of pay in the mercantile marine.

Systematic inspections have been continued in the various lighthouse districts of the technical work, business methods, and property accounts. The standard method of costkeeping has been continued, which is useful in preparing estimates, planning work, effecting economies, and comparing relative efficiencies.

A number of important items of construction work were in progress at the close of the year, including a new light and fog signal at Chicago Outer Harbor, Ill., Chester and Marcus Hook Ranges, Delaware River, and a light and fog signal at Conneaut, Ohio.

A temporary lighthouse depot is now rented at Ketchikan for \$3,900 per annum. It is too small for the work of the Service, is constructed wholly of wood, and contains many inflammable supplies, thus constituting a dangerous fire hazard. Practically no machinery or power tools are available, and the greater part of repair work must be performed at Seattle, 650 miles distant. An appropriation of \$90,000 for providing a new depot was made by the act of July 1, 1918, and work is now in progress on a reservation a short distance south of Ketchikan, made under Executive order of April 20, 1912. The plans contemplate a well-constructed wharf protected against the teredo, a fireproof storehouse, and the necessary shops and outbuildings.

An allotment was made from the fund for the national security and defense of the sum of \$175,000 for alterations at the general lighthouse depot at Tompkinsville, N. Y. The proposed changes will permit more rapid and economical coaling of vessels and provide more efficient repair facilities. Both will be available to the naval flotilla, which makes its base at this point.

During the fiscal year 1918, services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 158 occasions.

A severe hurricane visited the Gulf coast on September 27 to 29, 1917, damaging lighthouse property severely from the Mississippi River passes east to Pensacola Bay, and during the months of January and February, 1918, the unusually cold winter, the most severe of record since 1856, occasioned a large amount of ice damage on the Atlantic coast as far south as the Cape Fear River, S. C. Cross Rip Light Vessel No. 6, Mass., was lost in the ice, with six men on board. On August 6, 1918, Light Vessel No. 71 was sunk on her station on Diamond Shoals by an enemy submarine; the crew took to their boats and reached shore without injury.

The general lighthouse act approved June 20, 1918, contains provisions of much importance to the Lighthouse Service, including a retirement system for the field force, need for which has been pointed out from the first annual report of the Commissioner of Lighthouses in 1911 and emphasized in each succeeding report. Other important features of this act included more equitable compensation for the officers in charge of lighthouse districts, whose designation was changed from "lighthouse inspector" to "superintendent of lighthouses" and their salaries increased from \$2,400 to \$3,000 per annum, except in the third district, where the salary is \$3,600 per annum; for the raising of the pay of keepers of lighthouses and an increased ration allowance for them. Provision for the payment of travel and subsistence expenses of teachers instructing the children of lighthouse keepers and arrangements for the sale of publications of the Lighthouse Service were also included in this act, which authorizes a number of valuable special works of construction. The act as a whole is a great advance.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1919 are \$6,150,430, being \$811,750 in excess of those for the preceding fiscal year. In addition there are special appropriations aggregating \$723,000 for various new works.

An urgent need of the Lighthouse Service is new vessels. There are no surplus ships in the Service—no reserve vessels on which to call. The seagoing tenders have all been under extra service since the war began, adding important naval duty to their regular tasks. It is necessary to add several ships a year to the fleet merely to replace the wastage from work. This does not enlarge the fleet nor make it adequate to the growing demands upon it. Three lightships have been lost during the year—one by fire, one by ice, one by the act of the enemy. The sum of \$760,000

will be included in the estimates for new vessels. This is authorized by the act approved June 20, 1918. It provides merely for replacing vessels worn out in service in the third, fifth, and eighth lighthouse districts. It will not enlarge the fleet. It is all urgently required, and more will be necessary unless the important work of the Service is to fall behind.

The act of June 20 last also authorizes two matters of special importance not only to the commerce of the country but to the naval and military services. These are the enlarging and improving the lighthouse depot at Portsmouth, Va. (adjoining the navy yard there), or establishing a new depot there at a cost of \$275,000, and the improving the aids to navigation and installing new aids in the Potomac River to cost \$95,000. It is a constant waste of money to continue the use of the old Portsmouth depot. The vessels of the Service which use it as a basis are constantly delayed and their cost of operation increased through the insufficient and antiquated accommodation there afforded. The ships there must lie several deep because the wharf there is too small to give them individual dock space. Every day the old outfit is used involves a waste of public money. This matter is treated at length on page 183 of my last report.

The Potomac River is the poorest equipped, from a lighthouse standpoint, of our great eastern streams. The commerce on the river is increasing, and great sums have been spent for military and naval purposes at Quantico, at Camp Humphreys, and at Indianhead, all of them involving an increase in navigation. Naval vessels, sometimes with the nation's guests, navigate the river at night. Connecting, as it does, the nation's capital with one of our greatest harbors (Hampton Roads), it should be safeguarded better.

It is earnestly hoped that funds for the above purposes may be allowed at the next session of Congress, so that the work may be promptly begun in the spring.

The past year has been an unusually eventful and active one for the Service. The establishment of the retirement system for the field force and the furnishing of more adequate compensation for the light keepers and district officers mark a great step forward. I am glad to acknowledge the wise liberality of Congress in this respect.

To save space details are not given this year of the saving of life and property by the vessels and employees of the Lighthouse Service during the fiscal year. Many such cases have occurred, and the records of them appear in the files of the persons concerned.

COAST AND GEODETIC SURVEY.

(R. L. FARIS, *Acting Superintendent.*)

During the past year the activities of the Coast and Geodetic Survey have been directly connected with the war. Its principal finished product, navigational charts, has chiefly gone to Government war services. Its field operations throughout have been in response to specific calls from the military services for immediate surveys needed in the execution of their war programs. It has furnished to the Navy 5 ships (3 on the Atlantic and 2 on the Pacific). It has supplied the Navy with 42 commissioned officers, 10 other officers, and 79 men, a total of 131. It has supplied the Army with 25 commissioned officers, 26 other officers, and 58 men, a total of 109, making 240 men in the combined military services. This is 30 per cent of its force.

The war functions carried on by the remaining force are thus summarized:

Work for the Army through the Signal Corps and the Engineer Corps, and for the Navy through the Bureau of Operations, Bureau of Ordnance, Hydrographic Office, Bureau of Navigation, and Board of Inspection and Survey. For the Army the work was making control surveys, locating positions, and giving elevations in the States from Texas to Virginia, inclusive, as a basis for topographic maps. This is the basic or control work. The detail topographic work is being done by the Geological Survey. The Survey also fixed the location of towers for ordnance-test ground at Aberdeen, Md., and did other similar work.

For the Navy the work was in the form of wire-drag surveys and special surveys. Among such are the wire-drag surveys in Long Island Sound and in York River (Chesapeake Bay). A topographic survey of the Virgin Islands is under way for the Navy.

Special surveys included such work as the location of points for naval fire-control experiments, the reestablishment of the speed-trial course at Lewes, Del., for torpedo-boat destroyers, the location of the Port Jefferson trial course in Long Island Sound, and the Block Island (R. I.) trial course.

An important work was the preparation and production of charts; coast pilots, and tide tables for all vessels, new and old, of the merchant marine, including those operated by the United States Shipping Board and by the United States Railroad Administration. These charts and other publications are also supplied to the Army for the vessels of the War Department and in the coast fortifications; to the Navy for all vessels, both transports and ships of war. This work included supplying charts to the Navy officers generally, including vessels of Lighthouse Service and the Coast Guard, both now under naval control, and the supplying of special charts for the Signal Corps, the special board of the Navy Department, and others. This work was continuous, both in field and office, because of the constant corrections required and because new charts are always in preparation.

A war function of the Coast and Geodetic Survey was the use of its instrument shop for producing instruments at the request of the Bureau of Standards for artillery and aviation work in Europe, making original instruments for the National Advisory Committee for Aeronautics, furnishing sextants and other instruments, and repairing sextants for the Bureau of Navigation, Navy Department, through the Naval Observatory, etc.

Officers of this service are attached to the Naval Observatory to inspect navigational instruments for the Navy and are sent to factories manufacturing instruments to inspect them. A Survey officer is in charge of the naval hydrographic office in Norfolk, and others are detached for similar special duties, for instructing in navigation, etc.

The surveys accomplished for the military services during the year were necessarily limited to the remaining field officers and vessel equipment available for the work. The Bureau was unable to carry out all the work it was requested to do.

Field Work.

From the standpoint of units of classification, the field work done by the Bureau during the fiscal year ending June 30, 1918, may be expressed as follows:

Hydrography.—(1) Ship and launch hydrography, (2) wire-drag surveys, (3) revision work, (4) current observations, (5) tidal observations, (6) topography.

Geodesy.—(1) Triangulation, (2) precise levels, (3) magnetic observations.

Hydrography.

1. *Ship and launch hydrography.*—The vessels of the Bureau in commission within the year were as follows: *Surveyor*, *Bache*, *Isis*, *Matchless*, *Hydrographer*, *Patterson*, *Explorer*, *Yukon*, *Taku*, *Pathfinder*, *Fathomer*, *Marinduque*, *Research*, and *Romblon*.

The *Surveyor*, *Bache*, and *Isis* were requisitioned by the Navy Department as auxiliaries to the naval fleet and taken over by Executive order on September 24, 1917. Since that time they have been under the control of the Navy Department.

The *Explorer* was on field duty only during the first month of the fiscal year, the *Patterson* from the beginning of the year to the close of September 23, and the *Taku* less than a month. During 1918 the Navy Department felt the need of additional vessels to patrol the waters of the Pacific coast, and on May 16, 1918, the *Patterson* and the *Explorer* were transferred to the naval fleet by Executive order. The surveying seasons of the *Explorer* and *Taku* were necessarily prematurely closed because of the lack of crews, and the *Patterson*, *Explorer*, and *Taku* were not sent to the field in the spring of 1918 because of the lack of officers and difficulty of enlisting crews owing to labor conditions.

The *Taku* has been condemned and sold because it was worn out. The *Patterson* is old and weak, the *Explorer* structurally weak. Neither vessel is safe to send to the open sea again. In my last report, on page 214, the facts concerning these vessels are stated.

Of the five vessels that have been used by this Bureau in surveying the waters of the Philippine Islands, four belong to the insular government—namely, the *Fathomer*, *Marinduque*, *Research*, and *Romblon*. The officers of these were of the technical force of this Bureau. When the need for men with the technical qualifications of these officers in the Army and Navy became manifest more than half of this technical force was transferred to the military branches by Executive order. This required withdrawing many officers from service on the vessels loaned by the Philippine Government. In view of this and of the fact that the *Research* has nearly completed the survey of all sheltered waters where it is safe for her to go, and also on account of her age and weakened condition, it was considered unsafe to send her to survey exposed waters, and she was turned back to the insular government in December, 1917. The *Marinduque* was transferred back temporarily to the insular government on March 19, 1918.

The Service has fewer vessels than it had available 12 years ago. It has but one ship built for its duty, the *Surveyor*, and but two ships that can be said to be modern and in sound condition, the *Surveyor* and the *Isis*. With the vast amount of work ahead on which human life and property depend the vessel equipment is not only insufficient but most of it very poor. The Coast and Geodetic Survey is not responsible for the loss of life and property in unsurveyed waters. It has repeatedly requested the means for making these waters safe. Until those means are given it the loss of life and property must and will continue.

The survey of Sewalls Point, Va. (3 square statute miles), was asked by the Navy Department. It was accomplished in small boats and may be classed as launch hydrography.

The revision surveys of Pamlico, Croatan, and Roanoke Sounds, N. C. (395 square statute miles), were made, using launches and pulling boats.

The surveys in the York River, Va. (4.5 square statute miles), were made at the request of the Navy Department. This was all launch work.

The need of surveys of Mississippi Sound and Mobile Bay (1,690 square statute miles) and other surveys along the Gulf coast is shown in my report for 1917. About half of this may be classed as ship hydrography; the remaining half is launch hydrography.

Chesapeake Bay: Thirty-five miles of soundings were made; all ship work.

Approaches to Cross Sound, Lisianski Inlet and Strait, Alaska (2,317 square statute miles): About seven-eighths of this work may be classed as ship hydrography. The remainder was launch hydrography.

Northward from Cape Muzon, Alaska (3.8 square statute miles): About two-thirds of this work may be classed as ship hydrography. The remainder was launch hydrography.

Prince William Sound, Alaska (32 square statute miles): All launch hydrography.

Approaches to Burdeus Bay, Polillo Island, north coast of Polillo Island, and Cuyo Islands, Philippine Islands (1,516.5 square statute miles): About seven-tenths of this work was done by the vessel and the remainder by launches.

West coast of Busuanga Island, Philippine Islands (2,443.6 square miles): Nine-tenths of this was done by the ship and the remainder by launches.

Southeast coast of Palawan Island, Philippine Islands (1,312 square miles): About half of this was done by the ship and half by launches.

East coast of Palawan Island, Philippine Islands (1,134.4 square statute miles): About half of this was done by the ship and half by launches.

Manila Bay, Philippine Islands (315.5 square statute miles): About nine-tenths of this was done by the ship and the remainder by launches.

2. *Wire-drag surveys.*—There were five wire-drag parties in the field within the year.

Wire-drag party No. 1 operated in the approaches to Portsmouth Harbor, N. H., and in the vicinity of Block Island. This party was in the field from July 1 to September 27, 1917, and from May 6 to June 30, 1918. Ninety-seven square statute miles were dragged.

Wire-drag party No. 2 operated in Block Island Sound, Narragansett Bay and approaches, Long Island Sound, and vicinity of Eastport, Me. The party was in the field from July 1 to November 27, 1917, and from May 7 to June 30, 1918, and covered 167 square miles.

Wire-drag party No. 3 operated in Frederick Sound and Cook Inlet, Alaska. The party was in the field from July 1 to September 28, 1917, and from May 3 to June 30, 1918, and covered 230.2 square miles.

Wire-drag party No. 4 operated in the vicinity of Juneau, Alaska. The party was in the field from July 1 to September 11, 1917, and covered 72.7 square miles.

Wire-drag party No. 5 operated in the vicinity of Dry Tortugas, off the southern coast of Florida. The party was in the field from July 1 to September 29, 1917, and covered 140 square miles.

3. *Revision work.*—Revision work was done in the localities named below.

Plymouth, Mass.: 217.5 miles of sounding lines run.

Buzzards Bay, Mass.: 5 miles of triangulation and 3 square miles of hydrography.

South shore of Long Island Sound: 11 triangulation stations occupied 34 miles of shore-line run, 27.5 miles of railroads and other roads.

Vicinity of Seattle, Wash., Lake Washington Ship Canal: 3 triangulation stations occupied; 14½ square miles of topography and 3.75 square miles of hydrography completed.

4. *Current observations.*—The following are the general localities of the principal current observations made during the year and the number of stations occupied at each of these localities:

Locality.	Number of stations.
Block Island Sound.....	7
Coast of Maine.....	7
Long Island Sound.....	26
The Race, Long Island Sound.....	4
Port Jefferson, N. Y.....	3
Hampton Roads, Va.....	1

5. *Tidal observations.*—Tidal observations were made throughout the year at the following permanent tidal stations:

- | | |
|-------------------------|-------------------------|
| 1. Portland, Me. | 8. Key West, Fla. |
| 2. Fort Hamilton, N. Y. | 9. Cedar Keys, Fla. |
| 3. Atlantic City, N. J. | 10. Galveston, Tex. |
| 4. Philadelphia, Pa. | 11. San Diego, Cal. |
| 5. Baltimore, Md. | 12. San Francisco, Cal. |
| 6. Fernandina, Fla. | 13. Craig, Alaska. |
| 7. St. Augustine, Fla. | |

Important tidal observations were made at the following stations:

- | | |
|--------------------------|--------------------------|
| 1. New London, Conn. | 7. Petersburg, Alaska. |
| 2. New Haven, Conn. | 8. Canoe Cove, Alaska. |
| 3. Port Jefferson, N. Y. | 9. Miner Island, Alaska. |
| 4. Gloucester Point, Va. | 10. Auke Bay, Alaska. |
| 5. Pascagoula, Miss. | 11. McClure Bay, Alaska. |
| 6. Bay St. Louis, Miss. | 12. King Cove, Alaska. |

6. *Topography in connection with hydrographic work* was executed as follows:

Narragansett Bay and east end of Long Island Sound: 41.3 square miles.

Sewell Point, Va.: 1 square mile.

North Carolina sounds: 15 square miles of topography, 71 miles of shore line, and 18½ miles of railroads and other roads surveyed.

Mississippi Sound and Mobile Bay: 140 square miles of topography and 194.5 miles of shore line.

Cross Sound, Alaska: 32 square miles.

St. Thomas, Virgin Islands: 10 square miles.

Prince William Sound, Alaska: 40 square miles.

Stephens Passage, Alaska: 14.9 square miles.

Frederick Sound, Alaska: 126.25 square miles.

Coast of Alaska north of Cape Muzon: 10.5 square miles.

Knik Arm, Alaska: 2 square miles.

East Coast of Palawan, P. I.: 57 square miles.

Burdeus Bay, P. I.: 32.5 square miles.

Southeast coast of Palawan, P. I.: 45 square miles.

Manila Bay, P. I.: 47.2 square miles.

Northwest coast of Busuanga, P. I.: 4.5 square miles.

Geodesy.

Triangulation.—Primary triangulation was accomplished in the following localities: Along the Rio Grande in Texas, and in the vicinity of Stephens Passage and Lynn Canal, southeast Alaska; the total linear extent of this triangulation is 639 miles. Primary traverse was carried on in the following localities: Mostly in Georgia, but also in South Carolina and Virginia; the extent of this traverse is 940 miles. Tertiary triangulation was executed in the following localities: Along the Cape Fear River in North Carolina; the extent of this tertiary triangulation is 70 miles.

Precise levels.—During the year 2,367 miles of precise levels were run as follows: In Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, and Virginia.

Magnetic observations.—In continuation of the magnetic survey of the United States, observations were made during the year at 275 stations in 21 States, of which 118 were new primary stations, 114 auxiliary stations, 34 repeat stations for the determination of secular change, and 9 new stations in old localities. Meridian lines were established when they were requested by the local authorities. The number of county seats at which magnetic observations have not been made were reduced from 163 to 138.

The observatories at Cheltenham, Md.; Vieques, P. R.; Tucson, Ariz.; Sitka, Alaska; and near Honolulu, Hawaii, were in operation throughout the year. Continuous photographic records were secured of the variations of declination, horizontal intensity, and vertical intensity. Absolute observations were made at least once a week and scale-value determinations once a month. Beginning with January, 1918, horizontal-intensity observations as well as dip and declination were made both in the morning and in the afternoon on the same day to secure additional data regarding the relation between the variation and absolute instruments.

Need for Survey Vessels.

The most important class of hydrography is ship hydrography. There are thousands upon thousands of square miles of this class of hydrography that should be executed without further delay.

These are areas removed from the sight of land, exposed waters in extensive bays and sounds, and waters of these regions nearer shore where there is no refuge to permit using smaller craft. In such places results can be secured in no other way. These surveys are of the utmost importance to maritime commerce; in many instances the development of industries is retarded or prohibited because of the lack of these surveys. The Bureau is in need of proper ships with which to do this work.

This lack of adequate surveys is keenly felt by the shipping interests that risk their vessels in Alaskan waters. There are regions in which industries are awaiting development where these companies will under no consideration send ships because of certain but unknown dangers. This caution is grounded on experience, as is shown by a letter received from the general manager of the Pacific Steamship Co., under date of May 2, 1918, wherein he says in part:

At the present moment the Pacific Steamship Co. has two passenger steamers in trouble in southeastern Alaska as the result of "unavoidable strandings." First, the *Admiral Evans*, which struck an uncharted rock in the entrance of Hawke Inlet, as a result of which it was necessary to beach her immediately, where she now lies with her stern in 11 fathoms of water. Thirty days' salvage operations have failed of results and the best we can hope for is the loss of the use of the vessel for six months and a total expense of from \$300,000 to \$400,000 for recovery and repairs. After the accident a survey vessel was sent to the spot and discovered and buoyed the rock, thus adding one more expensive unit to the accidental survey of Alaskan waters.

Our steamship *Admiral Farragut*, while steaming north from Petersburg on April 26, struck an unknown obstruction, but where the chart showed 3 and $3\frac{1}{4}$ fathoms of water and the tide one hour to go; with the vessel drawing 19 feet 6 inches aft, probably not over 16 feet forward. Nos. 1, 2, 3, and 5 tanks are leaking. The pumps were able to keep her afloat until she arrived at Juneau, where she is now discharging cargo, and it will undoubtedly be necessary to bring her to Seattle for extensive repairs. I understand some of the Coast and Geodetic Survey people were aboard the *Admiral Farragut* when she struck, and you will probably be apprised of the details.

Here the loss of a single company operating steamers in Alaskan waters has been in two instances in excess of the entire appropriations for the Coast and Geodetic Survey by this Government for the current year for surveying the waters of Alaska, Washington, Oregon, California, the Philippine Islands, and Hawaii.

The annual loss of ships and cargoes in the waters of Alaska alone averaged \$490,000 for the 10-year period from 1906 to 1915, inclusive. This is more than enough at present prices to build a new surveying steamer every year and maintain her in full operation. A sum less than the cost of the wrecks for any two years of this 10-year period if spent in survey ships and crews would have prevented the other wrecks. Stated differently, there would have

been an approximate saving in eight years of \$3,920,000 in wrecks for the investment of less than \$960,000. This is at the rate of over 50 per cent per annum on the investment, but takes no account of the salvage of life.

While the results of the unsurveyed or partly surveyed waters bordering Alaska present a striking example of retarding a country's development when it could be stimulated so as to return a profit far beyond the cost of proper surveys, this condition is not peculiar to Alaska. Ship-borne commerce which is traversing some coastal waters of the continental United States escapes destruction more through the experience and knowledge of the navigator than by the guidance of charts that are supposed to contain all the information necessary for safety.

I may sum up the situation by comparing the area surveyed by the vessels of the Coast and Geodetic Survey in the waters of the three Pacific Coast States and Alaska during one year with the total area of these waters that remain to be covered by ship surveys. The table below gives a summation of the areas covered by the different vessels.

Name of vessel.	Field of operations.	Area covered in square statute miles.
Explorer.....	Richs Passage, Washington.....	0.5
Do.....	Cape Muzon, Alaska.....	574
Do.....	Dall Island, Alaska.....	209
Patterson.....	Kashevarof Islands, Alaska.....	90
Do.....	Cross Sound, Alaska.....	5.0
Taku.....	Orca Inlet and Copper River, Alaska.....	111.5
	Oregon.....	None.
	California.....	None.
Total.....		990

The total area in square statute miles of waters adjacent to Alaska, Washington, Oregon, and California that can not be surveyed by other than vessels of seagoing size and of which surveys are immediately necessary to make navigation safe is as follows:

	Square statute miles.
Alaska.....	587,000
Washington.....	11,500
Oregon.....	15,200
California.....	35,400
Total.....	649,100

The conclusion is inevitable that if these conditions are going to be remedied more surveying vessels must be put into the field in these waters. These ships are not an expense, but an investment. They pay large annual interest on their cost and maintenance. The present condition is a national reproach, a reflection on the humanity and sober business sense of our country.

Wire-Drag Launches.

While surveys of water area removed from the sight of land, exposed waters in extensive bays and sounds, and waters nearer shore, where there is no harbor for smaller craft, must be made by surveying ships, another class of hydrographic surveys can only be made with special power launches and special equipment—viz, the wire-drag survey. This is the only method of making effective surveys where prevailing depths are in excess of the needs of navigation, and yet there are obstructions projecting from the bottom which would damage or wreck a vessel that struck them.

The following table, which gives the wire-drag work now completed and that yet to be done, shows the necessity of proper equipment for wire-drag work:

Region.	Wire-drag surveys completed (square statute miles).	Wire-drag surveys to be made (square statute miles, approximated).
Coast of New England	1, 739	1, 800
Coast of Florida	216	500
Coast of Porto Rico	14	2, 300
Coast of Alaska	1, 638	50, 000
Entrance to Canal Zone	200	200
Total	3, 807	54, 800

The above table gives the principal areas where wire-drag surveys must be made; but there are many smaller localities where examinations are needed with the wire drag (such as San Francisco Harbor) and other extensive water areas where wire-drag work must eventually be done (such as the coral-infested waters of the Philippines, Hawaii, and Guam).

Enlistment of Seamen.

Three vessels available for certain surveys in Alaskan water were forced to lie idle at the docks in Seattle during most of

the fiscal year, the *Explorer* and *Taku* being in the field but a month each and the *Patterson* less than three months. This was because of the lack of officers and the difficulty of getting seamen to man the vessels. The vessels, such as they were, could have done more in protected waters if we had been able to get men.

The causes that lead to this state of affairs are many. The bad results have not been so manifest during normal times, though then matters were not going in a harmonious way. During the stress of war, however, when conditions were abnormal and an important arm of the Government service was thus crippled, the need of some remedial measures was keenly felt.

It is believed that there is a solution of this difficulty certain to result in efficiency and ultimately in great economy, though it involves an increased initial expenditure and a departure from present methods.

High efficiency can not be had in a service where the duties of its seamen are so different from the usual ones as to require months of special training and instruction before the seamen can become proficient, when such seamen are only employed for the surveying season of some six or seven months, are then discharged, and an entirely new crew recruited when the succeeding season opens.

Attention has been called to the need for additional surveys of the waters of Alaska and on the coasts of Washington, Oregon, and California.

The remedy suggested is this:

1. That surveying vessels be provided of a type sufficiently staunch to make surveys in Alaskan waters during the summer months and in the waters of Washington, Oregon, and California during the winter months and so equipped as to provide comfortable quarters for seamen throughout the year.

2. That the appropriations for manning the vessels of the Coast and Geodetic Survey be so increased that a standard wage can be paid the seamen on the vessels of this Service throughout the year.

3. That authority be granted to enlist seamen for service in the Coast and Geodetic Survey for a period of one year that will be binding upon them during the period of the enlistment, as are enlistments in the Navy and the Coast Guard.

From such an arrangement benefits are bound to accrue to both the seamen and the Government. The suggestion is predicated on the advantages being mutual. Employment for seamen will be

continuous under conditions that are agreeable, the Government will have trained complements of men on its vessels familiar with the intricate details of making surveys and will be able to draw to the Service competent and suitable seamen who will have before them prospects of continuous service and advancement in pay. Furthermore, surveys that are of vital importance to the protection of life and property will be accelerated far in excess of possible accomplishment under present conditions.

Additional Hydrographic and Geodetic Engineers.

While the regular work of the Coast and Geodetic Survey is now curtailed by war conditions, and the energies of those remaining in civil employment with the Bureau are directed toward accomplishments requested by the Navy and the Army, it is necessary to consider the needs of the Bureau for field officers to adequately perform the normal duties of the Service.

In the report of the Bureau for 1916 it was urged that 48 additional commissioned officers were needed to properly carry on its field work. In partial recognition of this need 20 new positions have been granted. This added personnel has been of great assistance in putting new life into the Service. The Bureau is, however, yet short 28 officers to put it on such a footing that the commissioned personnel will be sufficient to care for the field work.

Office Needs.

Draftsmen.—Stated in the order of the Bureau's present requirements, the classes of personnel where relief is urgently needed are as follows:

1. Draftsmen.
2. Computers.
3. Clerks.

The term "draftsmen" applied to the employees of the Coast and Geodetic Survey who compile the charts is a misnomer. The mechanical drawing of the characteristics shown on the published chart is by far the least duty of the force engaged. The more serious work is the examination of the mass of data from all sources, some of which are unquestionably accurate, others doubtful, and still others of uncertain character, and from these produce a chart that represents true conditions.

The military services have drawn some of our most experienced draftsmen, and others are on leave doing special war work. This only emphasizes a condition that has existed for years, namely,

that there is and has long been a great mass of information that has not and can not be applied to the charts of the Bureau at the time the information is current because there is not the necessary force of cartographers to digest and apply it as it comes in.

Because of the high attainments required of those engaged on this work the salaries should be higher than at present, especially in the lower grades. Indeed, if the positions are to be filled and conditions continue as at present these salaries must be increased, because candidates can not be found to fill them. Some of the lower paid positions have been vacant for months.

Computers.—The services of computers are required and used in three divisions of this Bureau.

1. In the division of geodesy in the computation of the results of geodetic surveys.

2. In the division of hydrography and topography in making computations for the annual tide tables and discussion of current data.

3. In the division of terrestrial magnetism in the computations of the field and observatory observations, and the discussion of the results therefrom.

While conditions are not as bad in these divisions and the masses of data from field observations, etc., are not so great as those before the draftsmen, yet there are many folios of results of field observations (geodetic, tidal, and magnetic) containing information that can only be effectively presented for public use in printed form that have not been reached by the computing force.

With the present scale of salaries, it is not possible to secure new computers of the required training and ability, nor to hold the old computers experienced in the work. Of the entire force (authorized) of 31 computers, there are only 6 now in the Service who were here at the beginning of 1907. In the division of geodesy, to which 22 of the computers are assigned, there are now only 2 who were there in 1907. Twelve places are either vacant or filled by temporary appointees.

Recently four men took the examination and all four men were offered positions at \$1,200 per annum, the regular entrance salary. One of these wanted \$2,000, another \$1,700, as an entrance salary, and the other two refused the position.

There has recently been a call for computers in the Ordnance Department, the requirements being substantially the same as for computers in the Coast and Geodetic Survey, the salaries ranging

from \$1,400 to \$1,800 a year. For master computer, with additional requirements of at least two years of experience in engineering or similar pursuits, salaries ranging from \$1,800 to \$2,400 a year are offered.

Clerks.—This Bureau in relation to its clerical force has few parallels in the Government service. The work of the Bureau is specialized. The clerical force is not large (42 in number). No two clerks in the Bureau have duties that are exactly similar, and the duties of many are highly technical. From this it follows that when a vacancy occurs in the clerical force the new appointee is assigned to duties which are different from any clerical experience he has had, and there is no clerk in the division to which he is assigned to assist him to learn his duties. He acquires this information only at the expense of a great loss of time of the chief of the division, who must teach him the details of the work. Consequently, frequent changes in the clerical force not only hinder the prompt answering of the inquiries of the public but retard the technical work of the Bureau.

Owing to the disparity between the statutory salaries in this Service and those paid in other branches of the Government, the changes in the clerical personnel are in excess of the average in other Government services.

The statutory salary of half of the clerical force of the Bureau is not in excess of \$1,000 per annum. There are 42 clerks in the Bureau. The statutory salaries of 21 of these are as follows:

Six at \$720 per annum.

Ten at \$900 per annum.

Five at \$1,000 per annum.

The result was that during the fiscal year no less than 27 persons occupied 5 of the statutory places at \$720 per annum and 33 persons occupied the 10 statutory places for clerks at \$900 per annum. The general average has been that these positions have been held less than three months, there being many intervals when candidates could not be found willing to accept such salaries.

While the Government has thus really paid from its salary rolls a minimum price for clerical help, it has lost an immense amount of time of highly skilled technical employees who have instructed during one year each of these 60 different incumbents of different clerical positions, and the net result has been a financial loss far in excess of salaries that would retain a permanent force.

Instrument Makers.

There is another need in the office personnel that has a direct effect on field work. This is an increased number of and higher entrance salary for instrument makers. These must be specially skilled men in repairing and making of the intricate parts of delicate surveying instruments, such as theodolites, sextants, levels, etc. We need men of higher attainments than are usually found in quantity-production instrument shops of manufacturers of surveying instruments. In those places men are generally skilled only in the production of special parts in numbers of a given instrument. The men in the Coast and Geodetic Survey shop must be able to make necessary parts for and repairs to any delicate surveying instrument and with high precision. An inaccuracy in the instrument would bring inaccuracies in the results from surveys made with it.

The entrance salary of \$1,200 does not attract men of the requisite experience to fill these positions. One of these positions was created July 1, 1917. It was only after a solicitation by correspondence and personal inquiry covering nearly six months that an incumbent was found. Another of the \$1,200 positions has been vacant for months. The Bureau is unable to induce anyone with mechanical ability to accept an appointment to fill the vacancy.

Retirement for Commissioned Officers.

In earlier reports mention has been made of the need of some system of retirement in order to bring about the maximum of results with the greatest economy. The Coast and Geodetic Survey is the oldest scientific bureau of the Federal Government, and naturally the defects attendant on superannuation are quite apparent.

The commissioned officers in the Coast and Geodetic Survey now number 124. Of these 10 are more than 64 years of age and have had an average service of over 44 years; 16 are over 60 years old and have had an average service of 42 years. To retire those above 64 years of age on three-fourths pay would have required an appropriation of but \$16,650 for the current year, and would have enabled us to bring into the service 10 new field officers who are sorely needed.

The fact that the pay of these officers during their long service has been too small to permit laying aside a competence for old age

is not, however, the principal consideration in urging retirement for them. The stronger reason is the privations they have to endure and the risks incident to the service. The surveys made by the Coast and Geodetic Survey ought to and usually do precede commerce, and often civilization. The surveying vessels of the service must enter, explore, and survey unknown waters in advance of commerce or of the vessels of the Navy, the Coast Guard, and of all other vessels. The hydrographic parties must go into unexplored waters and make examinations in order that the commerce to follow may be safe. In doing this work these parties are cut off from settlements and even from communications for weeks and months at a time. Often in the Philippines they live and work in direct contact with the uncivilized natives of the tropical forests bordering the waters where surveys are made.

The surveying work of this Service covers a wide field. Its officers are exposed to the tropical diseases and dangers of the Philippines and sent into the desolate Arctic regions. In connection with such work as the determination of the one hundred and forty-first meridian, the boundary line between Alaska and Canada, they have been for self-preservation forced to assume civil charge of the native population and exercise strict authority to stamp out smallpox.

In making surveys of Alaskan waters, officers are particularly exposed to dangers. The vessels they have had to use, small, old, and weak, are no match for the gales that are common to that country. It is only through foresight in selecting harbors of refuge and by good seamanship that disasters have been averted.

Though it is not the regular function of the Bureau, its officers play no small part in saving lives and property. Word often comes of assistance lent vessels in distress or lives and property saved. Persons have been rescued from stranded ships in all our waters by these officers. These risks and hardships are normal to the civil employment of the officers of the Coast and Geodetic Survey. In military activities also they have taken their part. In the Civil War 55 took an active part in the Army and 48 in the Navy, and their services are shown to have been highly prized by the testimonials of the military and naval officers under whom they served. They were in the Army and Navy without any military status and if captured would not have been accorded the protection of prisoners of war, but would have been subject to treatment as spies. Permanent legislation has been enacted authorizing the

President to commission and to transfer by Executive order to the Army or Navy the officers of the Coast and Geodetic Survey as necessity demands, in effect making the Service a military reserve force. In this way 25 commissioned officers have been transferred to the Army and 42 to the Navy. These officers are to-day taking all risks of military service.

The commissioned officers of the Coast and Geodetic Survey to be of normal efficiency must be a permanent force. That is to say, the work of the Bureau is so specialized in particular branches of the field of engineering that the young men that come to the Service from universities, where they are highly trained in the science of engineering, must have a long course of special training by the officers of the Coast and Geodetic Survey before they become proficient and are able to carry on the specialized work of the Bureau. It is only after years of experience and training that they become of the greatest value. Therefore, the young engineer must early determine either that he will cast his lot with the Coast and Geodetic Survey during his professional career or he must early seek other fields of service because his engineering work with the Bureau is highly specialized, and long training in it rather tends to make him less fit for successful effort in broader engineering fields. It, therefore, is true that those who have been in the Service more than a very few years are devoting their lives to the advancement of this special service.

These reasons justify a claim for retirement for the commissioned officers of the Coast and Geodetic Survey.

Recent Legislation.

The following is a summary of legislation contained in the sundry civil act of July 1, 1918, affecting the Coast and Geodetic Survey:

Among the important pieces of enabling legislation for the Service is the authorization of the payment of not to exceed \$1 per day as extra compensation to employees of the Lighthouse Service while observing tides or currents. Lightships are peculiarly well situated to collect tide and current data, but such observations are not part of the duty of the Bureau of Lighthouses and can not justly be imposed on the light keepers of that Service without additional compensation. The appropriations for the Coast and Geodetic Survey could not be used to recompense them for such additional duties without this authorization. It is expected that predictions can be made as the results of data collected on

lightships which will directly benefit navigators and save vessels from loss by providing knowledge of the direction and strength of ocean currents.

Other items are the authorization of the running of lines of precise levels in the interior of Alaska; the employment of draftsmen in the preparation of plans and specifications for vessels, and especially the reimbursement of officers of the Bureau for food, clothing, medicines, and other supplies furnished for the temporary relief of distressed persons in remote localities and to shipwrecked persons.

On March 16, 1918, the War Department requested the services of Dr. E. Lester Jones, Superintendent of the Coast and Geodetic Survey, in connection with the work of the supply division of the Signal Corps. Dr. Jones was temporarily released from his duties at the Coast and Geodetic Survey and was appointed by the War Department and given the rank of major and later promoted to lieutenant colonel, and since then has been commissioned colonel.

On August 16, 1918, Mr. William Bowie was transferred from the Coast and Geodetic Survey to the War Department and given the rank of major.

The personnel from the Coast and Geodetic Survey has received the following commissions in the War and Navy Departments:

WAR DEPARTMENT.		NAVY DEPARTMENT.	
Colonel.....	1	Lieutenant commanders.....	5
Major.....	1	Lieutenants.....	24
Captains.....	3	Lieutenants, junior grade.....	17
First lieutenants.....	18	Ensigns.....	4
Second lieutenants.....	10	Assistant surgeon.....	1

STEAMBOAT-INSPECTION SERVICE.

(GEORGE UHLER, *Supervising Inspector General.*)

Organization.

The following positions were embraced in the Steamboat-Inspection Service at the close of business on June 30, 1918:

At Washington, D. C.:

Supervising Inspector General.....	1
Chief clerk (who is acting Supervising Inspector General in the absence of that officer).....	1
Clerks.....	9
Messenger.....	1
	<hr/> 12

In the Service at large:

Supervising inspectors.....	10
Traveling inspectors.....	2
Local inspectors of hulls.....	48
Local inspectors of boilers.....	48
Assistant inspectors of hulls.....	64
Assistant inspectors of boilers.....	64
Clerks to boards of local inspectors.....	73
	<hr/> 309

Total..... 321

Nineteen permanent positions were added to the Service during the year, as follows:

One clerk in the office of the Supervising Inspector General, Washington, D. C.

A board of local inspectors was established at Tampa, Fla., consisting of a local inspector of hulls and a local inspector of boilers.

Three assistant inspectors of hulls and three assistant inspectors of boilers at the port of New York, N. Y.

One assistant inspector of hulls and one assistant inspector of boilers at each of the following ports: Seattle, Wash.; Philadelphia, Pa.; and Boston, Mass.

One additional clerk in each of the following offices: San Francisco, Cal.; Seattle, Wash.; Cleveland, Ohio; and Tampa, Fla.

Summary of Activities and Statistics.

Following is a summary of activities and statistics for the fiscal year 1918:

The force inspected and certificated 7,015 vessels, with a total gross tonnage of 8,464,696, of which 6,788 were domestic vessels.

with a total gross tonnage of 6,846,356, and 227 were foreign passenger steam vessels, with a total gross tonnage of 1,618,340. Of the domestic vessels there were 5,532 steam vessels, 695 motor vessels, 18 passenger barges, and 543 seagoing barges. There was an increase of 31 in the total number of vessels inspected and an increase of 1,215,107 in the total gross tonnage of vessels inspected as compared with the previous fiscal year. Letters of approval of designs of boilers, engines, and other operating machinery were granted to 33 steam vessels, with a total gross tonnage of 978. There were inspected for the United States Government 84 hulls and 1,716 boilers. There were 1,798 reinspections of passenger and ferry steamers. The two traveling inspectors traveled 17,872 miles, inspected 277 vessels, and found and reported 46 deficiencies of various kinds.

Licenses were issued to 32,458 officers of all grades. There were examined for visual defects 11,715 applicants for license, of whom 206 were found color blind or with other visual defects and rejected. Certificates of service were issued to 8,334 able seamen, and 600 were rejected. Certificates of efficiency were issued to 5,101 lifeboat men, and 786 were rejected.

Steel plates for the construction of marine boilers to the number of 9,605 were inspected at the mills, and a large amount of other boiler material was inspected. There were examined and tested 319,259 new life preservers, of which number 5,474 were rejected.

The total number of accidents resulting in loss of life was 217. The total number of lives lost was 500, of which 77 were passengers. Of the lives lost, 147 were from suicide, accidental drowning, and other causes beyond the power of the Service to prevent, leaving a loss of 353 as fairly chargeable to accidents, collisions, foundering, etc. There was a decrease of 92 in the number of lives lost as compared with the previous fiscal year. Passengers to the number of 335,141,118 were carried on vessels required by law to make report of the number of passengers carried. Dividing this number by 77, the total number of passengers lost, shows that 4,352,482 passengers were carried for each passenger lost. The number of lives saved by means of the life-saving appliances required by law was 1,356.

Part in the War With Germany.

The Steamboat-Inspection Service occupies an active position in the prosecution of the war against Germany, and everything possible has been done by the Service to make it more

efficient. Methods of administration have been improved, regulations adaptable to war conditions have been adopted, prompt investigations of instances of alleged disloyalty on the part of licensed officers have been held, and Congress has enacted important legislation for the Service, which has tended to efficiency.

The Steamboat-Inspection Service was so organized that there has been no delay whatever caused by administrative methods since the beginning of the war. Where improvements could be made they were made, and where short cuts could be taken they were taken. The work of the Service has increased enormously, but the personnel has not increased commensurately. It was, therefore, only by adopting effective methods that the Service was able to meet the demands upon it. The correspondence has been heavy since more business interests are giving their attention to maritime affairs and more persons wish information in regard to the merchant marine.

The office of the Supervising Inspector General was called upon to answer many questions relating to these matters. All information requested was furnished promptly, usually upon the same day. In some cases telegraphic instructions have been given to inspectors, that there might be no delay.

While the spirit of the Service is to adjust difficulties, as far as possible, by administrative authority, there are instances that require the adoption of regulations to meet situations that can not be so adjusted. Therefore, the Board of Supervising Inspectors has promptly adopted regulations with reference to the inspection of vessels and the licensing of men that have resulted in making conditions on board ships as safe as possible under war conditions, and at the same time have enabled men to obtain licenses who could not have been licensed under former rules. The work of the executive committees of the Board of Supervising Inspectors has been very effective in this connection as the committees meet when the board is not in session. The elasticity of this organization has proven very effective.

Ever since the war started the office of the Supervising Inspector General has been in correspondence with the Office of Naval Intelligence of the Navy Department concerning cases where that office reported instances of alleged disloyalty of persons holding licenses from the Steamboat-Inspection Service. In every such instance the local inspectors having jurisdiction have followed

down the reports and investigated the rumors. In those cases which were proven the licenses were promptly revoked.

In connection with the cooperative work of the Steamboat-Inspection Service of this Department with the United States Shipping Board it is interesting to note letter received from Mr. Edward N. Hurley, chairman of the Shipping Board, dated August 29, addressed to the Secretary of Commerce. The letter is as follows and calls particular attention to the need for additional inspectors and clerks, due to the constantly increasing demands made by the Shipping Board:

The attention of the Shipping Board has been directed to the need for increased personnel in the Steamboat-Inspection Service, through the letter from the Supervising Inspector General of that Service under date of August 28, 1918.

The urgent need for additional inspectors and clerks in the Steamboat-Inspection Service, we realize, is largely due to the constantly increasing demands made by the Shipping Board in the matter of new construction and in the training of new officers and engineers.

The Shipping Board desires to make acknowledgment of the efficient service rendered in the past by the Inspection Service, and it is loath to see a curtailment of this service or of the promptness of its execution due to a shortage of inspectors. It is essential in order that new construction be made available promptly that your continued cooperation be made available by adequate facilities.

Examination of Interned Vessels.

A tabulated statement follows, showing the places at which examined, the number, and the nationality of the vessels belonging to Germany and Austria which were interned and later seized by this country.

Port.	German.	Austrian.	Port.	German.	Austrian.
San Francisco.....	20	.....	Charleston.....	4	.....
Seattle.....	4	.....	New Orleans.....	7	2
Honolulu.....	10	.....	Mobile.....	2	1
New York.....	19	2	Galveston.....	.....	1
Philadelphia.....	2	1	Boston.....	3	1
Norfolk.....	2	1			
Baltimore.....	3	.....	Total.....	76	9

There were a few more vessels interned and taken over by the Government than appear in the table above; the figures show only those that were examined by inspectors of the Steamboat-Inspection Service.

Reference has been made in the press to the fact that there were certain interned vessels that were to be taken over, but unless one were familiar with the immense amount of work incident

to the examination of these vessels, the machinery of which was attempted to be ruined by men working under the direction of a foreign power, one can not appreciate the immense problem that confronted the inspectors of the Steamboat-Inspection Service in making an examination of the vessels.

It was necessary that the examination should be most thorough to ascertain exactly what was necessary to put these vessels into first-class condition. That the work of the Service was effective is proven by the very successful manner in which these ships have been operated since they have been flying the American flag.

Important Legislation.

During the fiscal year, by the act of Congress approved March 29, 1918, section 4472, Revised Statutes, was so amended as to provide that kerosene and lubricating oils made from refined products of petroleum, which will stand a fire test of not less than 300° F., may be used as stores on board steamers carrying passengers, under such regulations as may be prescribed by the Board of Supervising Inspectors, with the approval of the Secretary of Commerce.

The act of Congress approved June 10, 1918, has made it possible for appeals to be taken in practically every instance to the Supervising Inspector General, and when that officer's decision is approved by the Secretary of Commerce the action is final. The effect of the enactment of this law will be to result in a more centralized administrative authority and in increased efficiency.

The act of Congress approved July 2, 1918, resulted in a substantial increase of pay for the inspectors of the Service. Congress took timely action in enacting this law, because the Steamboat-Inspection Service faced practical disorganization. Prompt action should now be taken with reference to increasing the pay of the clerks of the Steamboat-Inspection Service. The persons who do this work have to be peculiarly qualified, and it is believed that unless prompt relief is given the machinery of the Service will be much impaired by the loss of competent clerks and the inability of the officers of the Service to obtain competent persons to take their places.

The Spirit of the Service.

The Steamboat-Inspection Service does things. In time of war or during crises men look for practical results. In such times men tie to leaders who act. Vessels have to be inspected, and that

promptly, and men must be licensed without delay. With this Service it is not a question of finding how not to do things, but how to do things. The time of day or night does not matter, nor do the hours of work. The clerks in the Steamboat-Inspection Service have responded splendidly to the unusual demands made upon them, because certificates of inspection have to be prepared and licenses have to be written out, not at convenience or several days after, but immediately when the necessity arises. An enormous amount of work has had to be done in the compilation of reports and data for other branches of the Government, and this has been done without delay. There has been no complaining, but there has been a cheerful response on the part of everyone to the unusual demands that have been made upon them.

BUREAU OF NAVIGATION.

(E. T. CHAMBERLAIN, *Commissioner.*)

American shipping registered for the foreign trade and enrolled and licensed for the coasting trade, including the fisheries, on June 30, 1918, comprised 26,711 vessels of 9,924,518 gross tons, compared with 26,397 vessels of 8,871,037 gross tons on June 30, 1917, an increase of 314 vessels and 1,053,481 gross tons. The following statement shows at a glance the total of our tonnage at the close of each of the last five fiscal years and indicates the great changes which have taken place within that period:

June 30—	Foreign trade.	Coasting trade.		Total.
		Great Lakes.	Sea and rivers.	
1914.....	1,076,152	2,882,922	3,969,614	7,928,688
1915.....	1,871,543	2,818,000	3,699,886	8,389,429
1916.....	2,191,715	2,760,815	3,517,119	8,469,649
1917.....	2,446,399	2,769,824	3,654,814	8,871,037
1918.....	3,603,706	2,708,523	3,612,289	9,924,518

These figures for June 30, 1918, must be supplemented by others outside of customhouse records to show adequately the situation. Thus, between April 6, 1917, when the United States declared war, and June 30, 1918, a total of 54 vessels of 404,760 gross tons were placed under control of the Army and Navy as transports and for other military and naval purposes, giving up for the time their registers and commercial character. Most of our seagoing ships, though still under register, have given up to a great extent their mercantile character and are owned or requisitioned by the Government of the United States as a necessary instrumentality for the prosecution of the war overseas. Thus, on June 30, 1918, the seagoing ships of over 1,000 gross tons each comprised 315 sail vessels of 518,216 gross tons and 965 steamers and motor ships of 3,788,676 gross tons. Of the total of 1,280 vessels of 4,306,892 gross tons the United States Shipping Board owned 265 ships of 1,031,564 gross tons and had under requisition 447 ships of 2,341,117 gross tons; in all 712 of 3,372,681 gross tons. The

power of requisition is a war power granted for war purposes, and the Shipping Board fleets are thus as essentially a war instrumentality as the Army transports, though in fact portions of the requisitioned fleet are still operating under direction of their owners as agents of the Shipping Board, in the trades in which they were engaged before the war. During the year 64 American ships of 163,254 gross tons were destroyed by German torpedoes and mines, with the loss of 326 lives.

The vessels built in the United States and documented as vessels of the United States during the fiscal year ended June 30, 1918, numbered 1,528 of 1,300,868 gross tons, compared with 1,297 of 664,479 gross tons during the year ended June 30, 1917, which was the record American output up to that date. Of the total 17 ships of 75,685 gross tons were built under contracts by and documented for the United States Shipping Board, including 2 wooden steamers of 6,068 gross tons. While the year's shipbuilding results may be below the popular expectations, they are in fact satisfactory in view of the difficulties under which the work was long prosecuted. Simultaneously with merchant shipbuilding our shipyards, especially those on the Atlantic coast, have carried on a larger amount of work on warships of various types than ever before in our history. Early in the fiscal year acts of Congress and large appropriations took effect which radically changed the nature of the shipbuilding industry in the United States. Some of these acts and appropriations were passed by Congress before June 30, 1917, but their full effect was not felt until the fiscal year began. The Government of the United States entered into contracts for the construction of great fleets of merchant ships, steel and wooden, in private shipyards, it aided in the establishment of new shipyards in various ways, and it took possession of a large tonnage in various stages of completion or under contract for American, British, French, Norwegian, and other shipowners. So radical a change in the industry naturally was not brought about without some delays and confusion, the effects of which in diminished production during the first part of the fiscal year are reflected in the year's output. During the ten months ended October, 1918, we built 2,082,251 gross tons, and if the present rate of construction is maintained, we shall build during the calendar year 1918 double the tonnage built during the fiscal year ended June 30, 1918. In the fiscal year we also built and delivered to foreign owners 22 vessels of 48,531 gross tons.

Shipping Commissioners.

During the year 457,248 officers and men have been shipped and discharged, including repeated shipments and discharges, by United States Shipping Commissioners, compared with 506,941 during the previous fiscal year. Nearly all the ports show a slight increase for the year, but at New York there was a decrease of 56,526, due to the change in policy by which enlisted men of the Navy to an increasing extent have been employed, instead of merchant crews, to man ships engaged in the transportation overseas of troops, supplies, and munitions of war.

Navigation Receipts.

The receipts from tonnage duties during the fiscal year amounted to \$1,171,418.36 (including \$4,633.14 Philippine Islands fund and \$3,362.50 alien and penal tonnage duties and light money). The total is \$222,324.80 less than the amount for the previous year. The reduction is due almost wholly to the great extent to which the transportation overseas of troops, munitions and supplies has taken the place of mercantile navigation. Such Government ships, of course, do not pay tonnage duties. As the Government's ownership and operation of ships under register increases, the receipts from tonnage duties may become somewhat illusory, because in fact one branch of the Government will in the last analysis be paying these duties to another, and essentially the transaction will be one of bookkeeping rather than of revenue.

Receipts from navigation fees amounted to \$146,508.02 compared with \$159,808.03 for the previous year, navigation and small miscellaneous fines amounted to \$32,097.68 compared with \$49,962.37 for the previous year, and excise tax of \$1,468.60 under the former yacht excise law was collected, navigation receipts thus amounting in all to \$1,351,492.66 compared with \$1,603,489.32 for the previous year.

Radio Communication.

Upon the declaration of war 18 of the 25 men in the radio-inspection force volunteered and were commissioned at once as officers in the Army and Navy. They have served with credit in responsible positions with our expeditionary forces in France, on the seas, and wherever assigned to duty. During the year the work has been continued by substitutes, who are also gradually leaving for military and naval service. They have made 4,341

inspections of ships out of 9,706 clearances compared with 6,103 inspections out of 12,139 clearances for the previous year. The demand of the Navy for wireless apparatus has been so great, coupled with the demand to equip increasing numbers of registered ships, that the distribution of apparatus has been under direction of the Navy Department. As the apparatus at times under the conditions can not fully comply with the law, it has seemed proper to arrange that the Navy Department which has allotted apparatus, should also inspect it, thus modifying the enforcement of the law. During the year the Bureau has licensed 1,942 commercial operators of various grades, compared with 680 during the previous year. The demand for skilled operators is very heavy, and to help meet it the radio inspectors, in addition to their statutory duties and with the cordial cooperation of collectors of customs and others, have opened schools of instruction for operators. From the Boston Customhouse School 200 students have entered the Army or Navy and 131 from the Detroit school.

Enforcement of the Navigation Laws.

During the year 4,749 violations of the navigation laws were reported and acted upon compared with 7,569 during the previous year. The decrease of 2,323 violations by motor boats may be attributed in part to the thorough inspection work of recent years, in part to the diminished use of such boats, and in part to rigid war regulations along the seaboard. Of the total violations, 2,654 were reported by customs officers, 1,422 by navigation inspectors, 809 by the motor vessel *Tarragon*, and 84 by the motor vessel *Kilkenny*, the motor vessel *Dixie* serving throughout the year as a naval dispatch boat at an important naval base. While the number of reported violations of law is less than last year, the inspections, especially so far as they involve safety to life, have been fully maintained.

To prevent overcrowding of passenger and excursion boats navigation inspectors during the year have made 13,576 counts of 4,916,772 passengers compared with 15,566 such counts of 6,796,441 passengers during the previous year. War activities have reduced the extent of passenger and excursion business at nearly all ports. On 385 occasions the inspectors stopped the boarding of passengers when limits were reached. During the year 32 owners of small vessels, mainly members of the United States power squadrons, gave their time and the use of their

boats at the nominal consideration of \$1 per annum in aiding in enforcing the navigation laws, and have rendered useful service to the Government which is appreciated.

Tonnage Admeasurement.

During the current calendar year the United States will build a larger tonnage of merchant ships than any other nation has ever built within a year, and at the present rate of construction during the calendar year 1919 our output will exceed any annual output of the rest of the world. Most of this shipping is seagoing, subject in the ports of the world to various charges based on tonnage admeasurement ascertained under the direction of the Bureau of Navigation. While at some ports the work is performed carefully and accurately by trained admeasurers, at others it is done by customhouse clerks temporarily detailed for the purpose. The rational way to meet the situation would be to group ship-building plants into districts for the purpose regardless of customs district lines, and create a small trained force to deal with the matter of admeasurement and also with the matter of load lines on which action can not be much longer deferred.

Motor Boats.

The act of June 7, 1918, requiring the numbering of undocumented motor boats will take effect December 7, 1918, but under war powers exercised by the Treasury and Navy Departments the regulations of the Bureau of Navigation at important seaports are already to an extent in effect. The act serves to identify small boats as automobiles are identified, and where the States have laws upon the subject satisfactory cooperation has been arranged. When the law is in full operation its benefits to all will be manifest. Incidentally, it is serving to render more workable some of the provisions of the internal revenue tax act which impose taxes on water transportation. The Bureau of Navigation and the Bureau of Internal Revenue have agreed on a mutually satisfactory way in which the motor vessels of the former shall cooperate in the collection of taxes by the latter while these vessels are performing their customary work.

CONCLUSION.

The foregoing is respectfully commended to your attention and to that of Congress.

Respectfully,

WILLIAM C. REDFIELD,

Secretary.

REPORTS
OF THE
DEPARTMENT OF COMMERCE

**BUREAU OF FOREIGN AND DOMESTIC
COMMERCE
BUREAU OF STANDARDS
BUREAU OF THE CENSUS
BUREAU OF FISHERIES
BUREAU OF LIGHTHOUSES**

**COAST AND GEODETIC SURVEY
STEAMBOAT-INSPECTION SERVICE
BUREAU OF NAVIGATION
APPOINTMENT DIVISION
DIVISION OF PUBLICATIONS**

REPORT
OF THE
CHIEF OF BUREAU OF FOREIGN AND DOMESTIC
COMMERCE

REPORT

OF THE

CHIEF, BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington, October 15, 1918.

SIR: In the following pages I lay before you an account of my stewardship as Chief of the Bureau of Foreign and Domestic Commerce for the fiscal year 1918.

The business life of the United States, of which this Bureau is the direct promotive agency, will emerge successfully from the destructive ordeal of war. In spite of the proper subservience of every Government agency to purely military purpose and despite the absorption of Government and private individuals in the furtherance of war aims, the foreign trade of the country has been kept alive by patriotic and far-sighted merchants, often working without profit, and aided by the unflagging zeal of the Bureau's staff.

In addition to this practical daily help there has been instituted in the Bureau a quality and volume of foreign-trade service such as no previous year has seen. This accomplishment is due largely to the fact that our commercial attaché and special agent personnel abroad has been developed until it is the best in our history. No finer body of trade experts will, in all probability, ever be assembled. The studies and current reports which they are now submitting constitute a library from which the business community will draw, through the Bureau's improved system of compilation and distribution, data and advice of profitable value for years to come.

In less degree do our statistics and trade data issue in a purely academic or perfunctory form; usefulness to business purpose is the test applied to every report and publication.

And a new measure of thoroughness, too, has been added to our habitual accuracy, in the face of every temptation to make speed the primary quality for war purposes. The Bureau experts have been held to the standard of their output and they have produced some very substantial work. Sir, it will gratify you to see the imposing list of business concerns, those of international importance and those of smallest size, which apply to the Bureau regularly for information and guidance.

REVIEW OF THE YEAR'S FOREIGN TRADE.

At the beginning of the fiscal year 1918 the American manufacturer and exporter was still seeking foreign trade wherever he could find it,

and he was encouraged rather than discouraged by the Bureau of Foreign and Domestic Commerce in his efforts. It was thought proper to supply the needs of the foreign customer as long as there was involved no interference with the war program. Eventually there came a time when the effective prosecution of the war demanded a cutting down of the huge volume of foreign sales to conserve tonnage and materials. Thereupon the Bureau ceased to promote the expansion of present business generally and turned its attention to the problems involved in keeping in close touch with the remaining available present markets and close investigation of all other markets, so that there will be the fewest possible obstacles in the way of resuming trade when the war is over. The investigations carried on in foreign fields are now aimed not at the stimulation of present business but at supplying the American manufacturer and exporter with the basic information that will help him to meet future competition.

Despite the restrictions on trade, however, the losses sustained by merchant shipping, by requisitioning of merchant shipping for transporting men, munitions, and supplies for our Army and Navy abroad, the shortage of bunker coal during several weeks of the winter, and the congestion of freight on the railroads and in the railroad terminals in this country, the foreign commerce of the United States during the fiscal year 1918 fell only slightly short of the 1917 record. Imports actually increased in value from \$2,660,000,000 in 1917 to \$2,946,000,000 in 1918, while exports showed only a slight decrease from \$6,290,000,000 in 1917 to \$5,920,000,000 in 1918. As a matter of fact, the loss of Russia's trade just about accounts for the entire loss in our export trade, so far as values are concerned. The increase in prices has had a part in maintaining these high levels. Nevertheless it is not an exaggeration to state that our foreign business has kept up remarkably well in the face of unparalleled difficulties. And it should be borne in mind that the goods carried in American transports for our troops in the field are not included in these statistics of foreign trade; it is only goods moved in merchant vessels that figure in our foreign-trade statistics.

The effect the war has had to date on the import and export trade of the country can in part be traced in the following table, which shows totals by months and fiscal years from 1913 to 1918:

IMPORTS AND EXPORTS OF MERCHANDISE INTO AND FROM THE UNITED STATES,
JULY, 1913, TO JUNE, 1918, BY MONTHS.

Month.	Imports.	Exports.	Excess of—	
			Imports.	Exports.
1913.				
July.....	\$129,061,770	\$160,990,778		\$31,929,008
August.....	137,651,553	187,909,020		50,257,467
September.....	171,084,843	218,240,001		47,155,158
October.....	132,949,302	271,861,464		138,912,162
November.....	148,236,536	245,539,042		97,302,506
December.....	184,025,571	233,195,628		49,170,057
1914.				
January.....	154,742,923	204,066,603		49,323,680
February.....	148,044,776	173,920,145		25,875,369
March.....	182,555,304	187,499,234		4,943,930
April.....	173,762,114	162,552,570	\$11,209,544	

IMPORTS AND EXPORTS OF MERCHANDISE INTO AND FROM THE UNITED STATES,
JULY, 1913, TO JUNE, 1918, BY MONTHS—Continued.

Month.	Imports.	Exports.	Excess of—	
			Imports.	Exports.
1914.				
May.....	\$164,281,515	\$161,732,619	\$2,548,896	.....
June.....	157,520,450	157,672,044	457,406	.....
Total, 12 months.....	1,893,925,657	2,364,579,148	.....	\$470,653,491
July.....	159,677,201	154,138,047	5,538,344	.....
August.....	129,767,890	110,367,494	19,400,396	.....
September.....	139,710,611	156,052,333	.....	16,341,722
October.....	138,080,520	194,711,170	.....	56,630,650
November.....	126,467,063	206,878,333	.....	79,411,271
December.....	114,656,545	245,632,558	.....	130,976,013
1915.				
January.....	122,148,317	267,879,313	.....	145,730,996
February.....	125,123,391	269,805,969	.....	174,682,478
March.....	157,962,016	296,611,832	.....	138,629,816
April.....	160,576,106	294,745,913	.....	134,169,807
May.....	142,284,851	274,218,142	.....	131,933,291
June.....	157,695,140	268,547,416	.....	110,852,276
Total, 12 months.....	1,674,169,740	2,768,589,340	.....	1,094,419,600
July.....	143,244,737	268,468,702	.....	125,223,965
August.....	141,804,202	260,609,965	.....	118,805,763
September.....	151,236,026	300,654,321	.....	149,418,295
October.....	149,172,729	336,152,009	.....	186,979,280
November.....	155,496,675	327,670,353	.....	172,173,678
December.....	171,682,606	359,306,362	.....	187,623,757
1916.				
January.....	184,350,942	330,036,410	.....	145,685,468
February.....	193,935,117	401,783,974	.....	207,848,857
March.....	213,589,786	410,742,034	.....	197,152,249
April.....	218,236,397	398,568,532	.....	180,332,135
May.....	229,188,967	474,803,637	.....	245,614,670
June.....	245,795,438	464,685,956	.....	218,890,518
Total, 12 months.....	2,197,883,510	4,333,482,885	.....	2,135,600,375
July.....	182,722,938	444,713,064	.....	261,990,126
August.....	199,316,480	510,167,438	.....	310,850,958
September.....	164,038,614	514,924,134	.....	350,885,520
October.....	178,658,730	492,813,918	.....	314,155,188
November.....	176,967,749	516,167,324	.....	339,199,575
December.....	204,834,188	523,233,780	.....	318,399,592
1917.				
January.....	241,793,282	613,324,582	.....	371,531,300
February.....	199,479,996	467,648,406	.....	268,168,410
March.....	270,267,139	553,965,699	.....	283,728,560
April.....	253,935,966	520,927,815	.....	275,991,849
May.....	280,727,164	546,673,545	.....	266,946,381
June.....	306,622,939	573,467,789	.....	266,844,850
Total, 12 months.....	2,650,355,185	6,290,048,394	.....	3,639,693,209
July.....	225,926,352	372,758,414	.....	146,832,062
August.....	267,854,767	498,655,597	.....	230,800,830
September.....	236,196,898	454,506,904	.....	218,310,006
October.....	221,227,406	542,101,146	.....	320,873,741
November.....	220,534,650	487,327,994	.....	266,793,344
December.....	227,911,497	600,135,006	.....	372,223,509
1918.				
January.....	233,942,081	504,797,306	.....	270,855,225
February.....	207,715,540	411,361,970	.....	203,646,430
March.....	242,162,017	522,900,238	.....	280,738,221
April.....	278,981,327	500,442,906	.....	221,461,579
May.....	322,582,598	550,924,791	.....	228,342,193
June.....	260,350,071	483,799,399	.....	223,449,328
Total, 12 months.....	2,945,655,403	5,919,711,371	.....	2,974,055,968

THE GOLD MOVEMENT.

Prior to the entrance of the United States into the war the trade balance shown by the excess of exports of merchandise over imports was liquidated largely by the imports of gold, mainly from England and Canada, into this country.

Within a few months after the declaration of war laws were passed enabling our Government to purchase the obligations of foreign Governments. Foreign obligations to the extent of \$4,738,000,000 were thus purchased during the fiscal year ended June 30, 1918, and consequently the continued large shipments of gold to this country became unnecessary, and receipts were reduced to \$124,000,000, as compared with \$977,000,000 for 1917 and \$494,000,000 for 1916.

Exports of gold from the United States were during the year regulated and licensed by the Federal Trade Board, and were thus greatly reduced after November, 1917, so that for the year the total amounted to only \$190,000,000 as compared with \$292,000,000 for the fiscal year 1917.

The trend of the gold movement, so far as it has been affected by the war, can be traced month by month in the following table:

IMPORTS AND EXPORTS OF GOLD INTO AND FROM THE UNITED STATES DURING THE FISCAL YEARS ENDED JUNE 30, 1915 TO 1918, BY MONTHS.

Month.	Imports.	Exports.	Excess of—	
			Imports.	Exports
1914				
July.....	\$3,391,715	\$33,669,424		\$30,277,709
August.....	3,045,219	18,125,617		15,080,398
September.....	2,761,590	21,887,202		19,125,612
October.....	5,945,003	50,301,972		44,356,969
November.....	7,391,729	14,526,482		7,134,753
December.....	4,109,063	130,924	\$3,978,139	
1915.				
January.....	6,896,398	691,509	6,204,889	
February.....	12,726,492	1,063,879	11,672,613	
March.....	25,620,467	923,891	24,696,576	
April.....	16,203,028	813,706	15,389,322	
May.....	31,136,311	1,277,554	29,858,757	
June.....	52,341,740	2,821,988	49,519,752	
Total, 12 months.....	171,568,755	146,224,148	25,344,607	
1916.				
July.....	17,262,938	2,191,735	15,071,203	
August.....	61,641,191	1,128,428	60,512,763	
September.....	42,062,449	2,033,990	40,028,459	
October.....	79,609,359	2,938,800	76,730,559	
November.....	60,981,540	3,061,153	57,920,387	
December.....	45,412,677	11,889,285	33,523,392	
1917.				
January.....	15,008,232	10,213,517	4,794,715	
February.....	6,016,006	13,684,667		7,668,661
March.....	9,776,439	10,774,354		997,915
April.....	6,121,788	11,502,999		5,381,211
May.....	27,321,943	11,918,597	15,403,346	
June.....	122,734,739	8,312,023	114,422,716	
Total, 12 months.....	494,009,301	90,249,548	403,759,753	
1918.				
July.....	62,107,665	9,395,035	52,712,630	
August.....	41,238,716	11,780,129	29,458,587	
September.....	92,562,247	6,849,141	85,713,106	
October.....	97,508,875	7,063,684	90,445,191	
November.....	46,972,903	26,835,062	20,637,841	
December.....	158,620,681	27,973,719	130,646,962	

IMPORTS AND EXPORTS OF GOLD INTO AND FROM THE UNITED STATES DURING THE FISCAL YEARS ENDED JUNE 30, 1915 TO 1918, BY MONTHS—Continued.

Month.	Imports.	Exports.	Excess of—	
			Imports.	Exports.
1917.				
January.....	\$58,926,258	\$20,719,898	\$38,206,360	.....
February.....	103,766,495	22,083,069	81,683,426	.....
March.....	139,498,590	17,919,601	121,578,989	.....
April.....	32,372,455	16,965,210	15,407,245	.....
May.....	52,262,090	57,697,419		\$5,435,329
June.....	91,339,051	67,164,268	24,174,783	.....
Total, 12 months.....	977,176,026	291,921,225	685,254,801	.....
July.....	27,303,798	69,052,357		41,748,559
August.....	18,692,170	46,049,306		27,357,136
September.....	4,171,535	31,332,896		27,161,361
October.....	4,149,582	11,154,074		7,004,492
November.....	2,806,476	7,223,100		4,416,624
December.....	17,066,874	4,538,136	12,527,738	.....
1918				
January.....	4,404,254	3,746,244	658,010	.....
February.....	2,549,168	5,084,060		2,534,892
March.....	1,912,862	2,809,359		896,497
April.....	2,745,727	3,560,084		814,357
May.....	6,620,516	3,598,946	3,021,570	.....
June.....	31,892,021	2,704,102	29,187,919	.....
Total, 12 months.....	124,413,483	190,852,224	.....	66,438,741

ANALYSIS OF THE IMPORT TRADE BY GREAT GROUPS.

The chief increase in imports for 1918 was in manufacturers' materials, the gain amounting to \$120,000,000 for crude materials and \$75,000,000 for partly manufactured materials. Imports of foodstuffs, both those in crude condition and those partly or wholly manufactured, show a small increase and formed almost the same percentage of the total importation as in the preceding year. Although finished manufactures increased \$17,000,000 in value, they formed a smaller percentage of the total importation than in any preceding year in the history of this country.

Of the manufacturers' raw materials, which continue to be the chief factor in the import trade, the principal articles showing increase in value during the year were: Raw wool, which increased from \$131,000,000 in 1917 to \$199,000,000 in 1918; crude fibers, from \$68,000,000 to \$100,000,000; raw furs, from \$22,000,000 to \$36,000,000; tobacco leaf, from \$25,000,000 to \$45,000,000; crude tanning materials, from \$19,000,000 to \$31,000,000; india rubber, from \$189,000,000 to \$203,000,000; and raw silk, from \$156,000,000 to \$181,000,000. Hides and skins decreased from \$216,000,000 to \$132,000,000.

The chief articles of food imported were sugar, coffee, tea, cocoa, fruits, and nuts. The quantity of sugar purchased abroad showed a reduction of about 10 per cent, but the value was greater than ever before—\$236,000,000 in 1918 as compared with \$231,000,000 in 1917. These figures do not include the value of sugar brought from Hawaii, which amounted to \$64,000,000 in 1918, nor that from Porto Rico, which amounted to \$41,000,000. Imports of fruits and nuts in-

creased from \$58,000,000 in 1917 to \$77,000,000 in 1918, cocoa from \$40,000,000 to \$41,000,000, and tea from \$19,000,000 to \$31,000,000. Coffee decreased from \$133,000,000 to \$103,000,000.

THE EXPORT TRADE BY GREAT GROUPS.

While there was a reduction in the total of exports for the year, the value of the exports of manufactured foodstuffs increased \$416,000,000 or 56 per cent over 1917 and \$860,000,000 or 294 per cent over 1914, and amounted to \$1,153,000,000. During March, April, and May of this year the value of the exports of meat and dairy products were more than ten times as great as for the corresponding months of 1914. These figures indicate in an impressive manner the results of the efforts made by this country to furnish food to our allies.

In addition to the manufactured foodstuffs there were shipped abroad \$875,000,000 worth of foodstuffs in a crude condition and food animals.

The exports of manufacturers' materials increased from \$732,000,000 in 1917 to \$897,000,000 in 1918, a gain of \$165,000,000. This gain is accounted for almost entirely by the increased values of cotton, coal, and tobacco. The value of the cotton exported was \$665,000,000—the greatest ever attained—and exceeded 1917 by 22 per cent, though the quantity was only 4,500,000 bales—the smallest amount since 1893—and was less than one-half the amount exported in 1914.

Notwithstanding the apparent shortage of coal in this country, we exported more of that commodity, both in quantity and value, than in any previous year. The value advanced from \$83,000,000 in 1917 to \$112,000,000 in 1918, or 35 per cent, while the quantity increased from 24,000,000 long tons to 26,000,000 long tons, or 8 per cent.

The value of leaf tobacco exported in 1918 was \$70,000,000, an increase of \$10,000,000 over the preceding year, but the quantity was 289,000,000 pounds in 1918 as compared with 406,000,000 in 1917.

The fact that the business of primary importance in this country during the past year has been the manufacture of ammunition and supplies for the use of our Army and Navy at home and abroad was clearly shown in the reduction of \$750,000,000 in the export of manufactured articles. The principal commodities showing reduction were: Explosives, from \$803,000,000 in 1917 to \$379,000,000 in 1918; brass and its manufactures, from \$383,000,000 in 1917 to \$61,000,000 in 1918; firearms, from \$95,000,000 to \$49,000,000; leather and its manufactures, from \$154,000,000 to \$101,000,000.

These figures, it must always be remembered, represent the values of the merchandise exported to foreign countries on cars or on merchant vessels and do not include supplies transported abroad on United States Army and Navy transports.

Imports into the United States, classified by great groups according to use and degree of manufacture, during the fiscal years 1914, 1917, and 1918 are shown in the following table:

Great groups.	1914		1917		1918	
Crude materials for use in manufacturing.....	<i>Value.</i> \$632,865,860	<i>Per ct.</i> 33.42	<i>Value.</i> \$1,109,704,565	<i>Per ct.</i> 41.73	<i>Value.</i> \$1,230,252,430	<i>Per ct.</i> 41.76
Foodstuffs in crude condition, and food animals.....	247,947,621	13.09	335,573,042	12.62	372,681,751	12.65
Foodstuffs partly or wholly manufactured.....	227,644,329	12.02	343,435,475	12.91	380,227,084	12.9
Manufactures for further use in manufacturing.....	319,275,488	16.86	477,730,509	17.96	540,742,182	18.26
Manufactures ready for consumption.....	449,318,214	23.72	377,256,553	14.19	402,670,415	13.67
Miscellaneous.....	16,874,145	.69	15,655,041	.59	19,081,541	.65
Total imports of merchandise.....	1,893,925,657	100.00	2,659,355,185	100.00	2,945,655,403	100.00

Domestic exports from the United States, classified by great groups according to use and degree of manufacture, during the fiscal years 1914, 1917, and 1918 are shown in the following table:

Great groups.	1914		1917		1918	
Crude materials for use in manufacturing.....	<i>Value.</i> \$792,716,109	<i>Per ct.</i> 34.03	<i>Value.</i> \$731,990,339	<i>Per ct.</i> 11.76	<i>Value.</i> \$897,324,082	<i>Per ct.</i> 15.37
Foodstuffs in crude condition, and food animals.....	137,495,121	5.90	531,866,009	8.54	374,978,216	6.42
Foodstuffs partly or wholly manufactured.....	293,218,336	12.59	737,705,334	11.85	1,153,702,460	19.76
Manufactures for further use in manufacturing.....	374,224,210	16.06	1,191,262,523	19.13	1,201,439,423	20.58
Manufactures ready for consumption.....	724,908,000	31.11	2,942,577,415	47.25	2,185,420,221	37.43
Miscellaneous.....	7,122,249	.31	91,672,430	1.47	25,787,655	.44
Total domestic goods.....	2,329,684,025	100.00	6,227,164,050	100.00	5,838,652,057	100.00
Export of foreign goods.....	34,895,123	.....	62,884,344	.....	81,069,314	.....
Total exports.....	2,364,579,148	.....	6,290,048,394	.....	5,919,721,371	.....

IMPORTS BY GRAND DIVISIONS AND COUNTRIES.

Both imports and exports in the trade of the United States with every grand division except Europe show substantial increases. Imports from Europe were \$412,000,000 and were the smallest since 1899 and less than one-half the value in 1914. The chief reduction in imports occurred in commerce with the United Kingdom and France. Imports from the former decreased from \$308,000,000 in 1917 to \$190,000,000 in 1918 and those from France from \$108,000,000 to \$76,000,000.

Increases in imports during 1918 as compared with 1917 occurred principally in trade with the following countries: Canada, from \$321,000,000 to \$434,000,000; Argentina, from \$153,000,000 to \$196,000,000; Japan, from \$208,000,000 to \$285,000,000; Australia and New Zealand, from \$19,000,000 to \$61,000,000; and British Africa, from \$25,000,000 to \$50,000,000. Imports from Asia increased \$211,000,000 and from North American countries \$152,000,000.

Further information along this line will be found in the following table:

TOTAL VALUES OF IMPORTS OF MERCHANDISE INTO THE UNITED STATES, BY PRINCIPAL COUNTRIES AND GRAND DIVISIONS, DURING THE FISCAL YEARS ENDED JUNE 30, 1914 TO 1918.

Country.	1914	1915	1916	1917	1918
Europe:					
Austria-Hungary	\$20, 110, 834	\$9, 794, 418	\$1, 430, 985	\$225, 452	\$12, 766
Belgium	41, 035, 532	10, 222, 860	1, 478, 579	1, 029, 261	90, 053
France	141, 446, 252	77, 158, 740	102, 077, 620	108, 069, 706	75, 638, 078
Germany	189, 919, 136	91, 372, 710	13, 945, 743	1, 524, 693	64, 094
Italy	56, 407, 671	54, 973, 726	57, 432, 436	46, 374, 368	30, 014, 349
Netherlands	36, 294, 010	82, 518, 890	38, 534, 509	31, 842, 144	16, 396, 633
Norway	9, 197, 265	10, 668, 864	6, 851, 714	7, 108, 311	3, 235, 020
Russia in Europe	20, 831, 184	2, 512, 381	3, 613, 986	5, 446, 095	15, 146, 826
Spain	24, 658, 867	18, 027, 492	27, 864, 130	36, 862, 571	24, 565, 565
Sweden	11, 590, 107	11, 661, 337	11, 846, 881	23, 642, 433	10, 676, 354
Switzerland	25, 329, 609	1, 335, 483	21, 775, 413	20, 252, 954	18, 862, 990
United Kingdom	293, 681, 304	256, 351, 675	308, 443, 223	307, 674, 833	190, 062, 456
Other Europe	25, 121, 007	19, 756, 069	20, 957, 580	20, 417, 829	26, 843, 310
North America:					
Canada	160, 689, 709	159, 571, 712	204, 018, 227	\$20, 949, 492	434, 254, 567
Central America	17, 842, 591	21, 234, 665	25, 899, 607	35, 956, 874	40, 182, 110
Mexico	92, 690, 566	77, 612, 691	97, 676, 544	112, 138, 677	140, 659, 542
British West Indies	15, 550, 859	13, 252, 362	14, 404, 754	16, 769, 466	14, 122, 455
Cuba	131, 303, 794	185, 706, 901	228, 977, 567	253, 395, 410	264, 024, 006
Other North America	9, 321, 835	15, 701, 465	20, 918, 844	26, 882, 618	25, 104, 686
South America:					
Argentina	45, 123, 988	73, 776, 298	112, 512, 420	152, 612, 411	195, 633, 348
Brazil	101, 329, 073	99, 178, 728	165, 663, 984	151, 638, 245	113, 511, 954
Chile	25, 722, 128	27, 689, 780	64, 154, 859	113, 789, 130	141, 075, 704
Colombia	16, 061, 120	18, 953, 023	21, 458, 029	28, 965, 920	25, 975, 988
Peru	12, 175, 723	12, 596, 048	24, 326, 689	36, 379, 016	41, 580, 778
Uruguay	7, 715, 144	10, 492, 649	14, 475, 478	30, 406, 532	23, 530, 682
Venezuela	9, 763, 069	13, 227, 238	14, 942, 448	15, 018, 567	13, 287, 738
Other South America	4, 796, 830	5, 575, 290	7, 028, 111	13, 402, 999	12, 822, 070
Asia:					
China	39, 382, 978	40, 156, 139	71, 655, 045	105, 905, 531	116, 644, 981
East Indies (British)	111, 903, 527	87, 177, 237	177, 423, 346	217, 610, 056	296, 606, 132
Japan	107, 355, 997	98, 882, 638	147, 644, 228	208, 127, 478	284, 945, 439
Other Asia	28, 310, 084	21, 554, 089	40, 458, 645	83, 574, 398	127, 997, 090
Oceania:					
Australia and New Zealand	22, 213, 570	27, 244, 039	64, 553, 441	18, 874, 571	61, 308, 268
Philippine Islands	18, 162, 312	24, 020, 169	28, 232, 249	42, 436, 247	78, 101, 412
Other Oceania	1, 768, 516	1, 258, 344	3, 440, 301	4, 017, 561	6, 796, 032
Africa:					
British Africa	3, 956, 581	6, 090, 857	26, 759, 970	25, 298, 667	50, 497, 455
Egypt	13, 311, 233	17, 371, 992	33, 254, 943	29, 728, 445	20, 907, 998
Other Africa	1, 881, 662	1, 490, 232	4, 750, 532	4, 991, 204	4, 506, 544
Total	1, 893, 925, 657	1, 674, 169, 740	2, 197, 883, 510	2, 659, 355, 185	2, 945, 655, 403
RECAPITULATION.					
Europe	895, 602, 868	614, 354, 645	616, 252, 749	610, 470, 670	411, 578, 494
North America	427, 399, 354	473, 079, 796	591, 895, 543	766, 112, 537	918, 347, 346
South America	222, 677, 375	261, 489, 563	391, 562, 018	542, 212, 820	567, 418, 257
Asia	286, 952, 486	247, 770, 103	437, 181, 464	615, 217, 463	826, 193, 642
Oceania	42, 144, 398	52, 522, 552	96, 225, 991	65, 328, 379	146, 205, 707
Africa	19, 149, 476	24, 953, 081	64, 785, 745	60, 013, 316	75, 911, 957

EXPORTS BY GRAND DIVISIONS AND COUNTRIES.

Probably the most noteworthy increase in our exports has been that in the trade with Japan, total exports to which grew from \$130,000,000 in 1917 to \$268,000,000 in 1918, owing largely to the great amounts of steel shipbuilding material shipped during the year. During 1914 we sent Japan only \$51,000,000 worth of goods, so that the 1918 figures are more than five times that amount.

The export trade with South America increased to more than three times the value reached in 1915; that with Chile increasing from \$11,000,000 in 1915 to \$64,000,000 in 1918; that with Argentina from \$33,000,000 in 1915 to \$109,000,000 in 1918; and that with Brazil from \$26,000,000 to \$66,000,000.

The principal decreases in our export trade occurred in the commerce with Europe. Nearly every European country shows reduced totals. The exceptions are Belgium and Italy. The shipments to Belgium were \$95,000,000, mostly food for the Belgium Relief Commission, compared with \$37,000,000 during 1917. Italy received \$478,000,000 during 1918 and \$361,000,000 during 1917.

Exports to all the neutral countries of Europe fell off to a marked degree, being about \$230,000,000, or only one-third as much as during the preceding year. Exports to Russia in Europe and Asia were reduced from \$559,000,000 in 1917 to \$151,000,000 in 1918.

The steady increase in our exports to Cuba was continued during the past year and reached \$235,000,000, as against \$178,000,000 for 1917 and \$69,000,000 in 1914. The trade with Mexico has also increased and was one-third greater during 1918 than during 1917, being \$107,000,000 as against \$79,000,000. Details are shown in the table that follows:

TOTAL VALUES OF EXPORTS OF MERCHANDISE, BY PRINCIPAL COUNTRIES AND GRAND DIVISIONS, DURING THE FISCAL YEARS ENDED JUNE 30, 1914 TO 1918.

Country.	1914	1915	1916	1917	1918
Europe:					
Austria-Hungary.....	\$22,718,258	\$1,238,669	\$146,302	.....	.....
Belgium.....	61,219,894	20,662,315	21,848,114	\$37,367,997	\$95,390,695
Denmark.....	15,670,135	79,824,478	55,872,312	56,738,490	4,969,542
France.....	159,818,924	369,397,170	628,851,988	1,011,667,206	883,734,921
Germany.....	344,794,276	28,863,354	288,899	2,199,449	.....
Italy.....	74,235,012	184,819,688	269,246,105	360,608,356	477,898,774
Netherlands.....	112,215,673	143,267,019	97,476,328	109,082,168	6,381,964
Norway.....	9,066,610	39,074,701	53,645,295	82,001,636	25,216,242
Russia in Europe.....	30,088,643	37,474,380	178,694,800	428,688,107	116,705,346
Spain.....	30,387,569	38,112,969	52,836,721	76,978,350	67,163,288
Sweden.....	14,644,226	78,273,818	51,979,745	44,683,512	4,122,550
Switzerland.....	1,019,602	2,735,788	8,062,516	22,325,779	21,246,078
United Kingdom.....	594,271,863	911,794,954	1,526,685,102	2,046,812,678	1,995,863,297
Other Europe.....	16,348,044	35,895,384	53,650,870	45,358,933	37,481,655
North America:					
Canada.....	344,716,981	300,686,812	468,784,793	787,177,099	778,490,022
Central America.....	39,439,117	33,585,728	41,703,906	52,517,749	43,582,982
Mexico.....	38,748,793	34,164,447	47,945,519	79,004,597	107,077,033
British West Indies.....	13,357,010	11,879,591	16,230,039	21,934,827	22,925,036
Cuba.....	68,884,428	75,530,382	127,198,578	178,292,328	235,469,608
Other North America.....	23,498,633	21,228,767	31,161,839	44,831,500	48,814,332
South America:					
Argentina.....	45,179,089	32,549,606	66,378,366	82,375,165	109,373,150
Brazil.....	29,963,914	25,629,555	40,572,197	56,727,234	66,270,046
Chile.....	17,432,392	11,377,181	24,239,826	44,538,993	63,529,124
Colombia.....	6,786,153	6,675,564	11,666,932	14,921,569	10,994,199
Peru.....	7,141,252	5,873,474	9,526,230	18,828,884	22,011,583
Uruguay.....	5,641,266	5,171,323	10,287,384	14,297,113	18,064,890
Venezuela.....	5,401,386	5,764,442	9,068,998	12,880,445	7,823,007
Other South America.....	6,994,457	6,282,812	8,415,441	14,910,968	16,492,806
Asia:					
China.....	24,698,734	16,402,475	25,131,459	37,185,608	43,476,623
East Indies (British).....	15,628,195	15,960,734	24,696,872	37,108,127	52,262,943
Japan.....	51,265,520	41,517,780	74,470,931	130,427,061	267,641,212
Russia in Asia.....	1,214,506	23,353,151	131,111,792	130,206,338	34,718,541
Other Asia.....	20,681,661	17,216,353	28,199,527	45,312,574	49,299,948
Oceania:					
Australia and New Zealand.....	54,725,240	51,986,649	74,002,526	80,398,265	83,960,179
Philippine Islands.....	27,304,587	24,755,320	28,421,172	27,206,612	48,425,088
Other Oceania.....	1,538,490	1,022,756	1,352,130	1,709,613	2,505,921
Africa:					
British Africa.....	18,960,770	18,371,085	28,399,377	32,774,323	44,747,874
Other Africa.....	8,940,745	10,248,666	15,191,654	19,958,741	9,550,883
Total.....	2,364,579,148	2,768,589,340	4,333,482,885	6,290,048,394	5,919,711,371
RECAPITULATION.					
Europe.....	1,486,498,729	1,971,434,687	2,999,305,097	4,324,512,661	3,732,174,352
North America.....	528,644,962	477,075,727	733,024,674	1,163,758,100	1,236,359,013
South America.....	124,530,909	99,323,957	180,175,374	259,480,371	314,558,794
Asia.....	113,425,618	114,470,493	278,610,881	380,249,708	447,429,267
Oceania.....	83,568,617	77,764,725	98,775,828	109,314,490	124,891,188
Africa.....	27,901,515	28,519,751	43,691,031	52,733,064	54,298,767

EXPORTS BY QUANTITIES.

The high total value of exports for the year is due to increased quantities as well as to the high prices. Twenty-four of the commodities in the table given below show increases, and in some instances vast increases, during the past year as compared with 1914, while only nine commodities show decreases.

Coal shows an increase from less than 20,000,000 long tons in 1914 to nearly 26,000,000 long tons in 1918. There is an increase of over 10,000,000 barrels of wheat flour during the same period; oats increased from less than 2,000,000 bushels to 106,000,000 bushels. Exports of steel sheets and plates more than doubled from 1914 to 1918, steel cars almost quadrupled, and bacon, hams, beef, and sugar show greatly increased shipments in quantities.

DOMESTIC EXPORTS OF PRINCIPAL ARTICLES FROM THE UNITED STATES TO FOREIGN COUNTRIES, DURING THE FISCAL YEARS ENDED JUNE 30, 1914 TO 1918, BY ORDER OF MAGNITUDE IN QUANTITY IN 1918.

Article.	1914	1915	1916	1917	1918
Coal.....tons.	19,664,080	18,095,183	22,628,162	24,168,839	25,894,166
Mineral oil, refined.....M gallons.	2,135,134	2,034,826	2,279,715	2,570,580	2,491,967
Billets, ingots, etc., of steel.....tons.	46,926	220,416	962,097	1,935,026	1,970,831
Wheat flour.....barrels.	11,821,461	16,182,765	15,520,669	11,942,778	21,879,951
Lumber, boards, planks, etc.....M feet.	2,417,439	1,135,212	1,777,331	1,041,845	1,067,709
Oats.....bushels.	1,859,949	96,809,551	95,918,884	88,944,401	105,837,309
Cotton, unmanufactured.....M pounds.	4,760,941	4,403,578	3,084,070	3,088,081	2,320,512
Wheat.....bushels.	92,393,775	259,642,533	173,274,015	149,831,427	34,118,853
Bars or rods of steel.....M pounds.	460,557	736,322	1,785,538	2,009,743	1,790,466
Sheets and plates.....do.	834,314	637,193	1,100,782	1,551,062	1,773,268
Rails of steel.....tons.	338,613	159,587	537,918	694,399	430,347
Copper pigs, ingots, bars, etc.....M pounds.	974,792	677,154	711,342	1,021,094	931,670
Pig iron.....tons.	201,995	130,694	286,728	834,930	377,012
Bacon.....M pounds.	193,964	346,718	579,809	667,152	815,294
Wire, barbed and other.....do.	367,599	657,791	1,379,961	1,221,596	794,072
Sugar, refined.....do.	50,896	549,007	1,630,151	1,248,908	576,453
Tin plates, terneplates, etc.....do.	105,900	179,222	516,257	521,861	560,069
Structural iron and steel.....tons.	296,282	168,664	270,311	339,498	240,394
Milk, condensed and evaporated. M pounds.	16,209	37,236	159,578	259,141	528,759
Beef, fresh, canned, etc.....do.	33,225	277,559	320,132	322,767	521,844
Hams and shoulders, cured.....do.	165,882	203,701	282,209	266,657	419,572
Pipes and fittings.....do.	539,246	403,390	399,250	547,331	404,989
Lard.....do.	481,458	475,532	427,011	444,770	392,506
Oatmeal and rolled oats.....do.	15,998	68,395	54,749	110,903	346,560
Gunpowder.....do.	889	7,696	212,821	404,669	337,506
Cotton cloth.....M yards.	414,860	396,944	550,572	690,194	684,927
Printing paper.....M pounds.	117,599	156,944	200,718	274,295	310,434
Tobacco, unmanufactured.....do.	449,750	348,346	443,293	411,599	289,171
Nails.....do.	97,579	142,397	819,776	333,432	284,983
Zinc, spelter, etc.....do.	3,996	266,680	243,333	475,729	263,571
Paraffin.....do.	186,358	330,374	360,650	348,744	246,094
Rice.....do.	18,223	75,449	120,695	181,372	196,363
Brass plates and sheets.....do.	5,466	40,282	133,106	393,493	93,541

IMPORTS BY QUANTITIES.

On the import side the increases in the quantities of the principal commodities are noteworthy.

Mineral oil was the leading commodity in weight imported during 1918, and exhibits a gain of over 75 per cent in excess of 1914. Imports of wheat increased from less than 2,000,000 bushels in 1914 to 28,000,000 bushels in 1918. Soya beans show the greatest proportionate gain, the 1918 importations being over twenty times those of 1914; imports of copra were nine times those of 1914; zinc ore and calamine were more than five times those of 1914; importations of

coconut oil and lead ore and bullion were trebled and those of cocoa, printing paper, and manganese ore were doubled.

Very few of the quantities of the principal imported articles show reduced totals for 1918 as compared with 1914. Owing to the reduced shipments from Cuba, imports of iron ore were decreased about 60 per cent. Receipts of hides and skins fell off 23 per cent; cotton, 17 per cent; burlaps, 11 per cent; and there were smaller reductions in sugar, sulphur ore, wood pulp, and chromate of iron.

IMPORTS OF PRINCIPAL ARTICLES INTO THE UNITED STATES FROM FOREIGN COUNTRIES DURING THE FISCAL YEARS ENDED JUNE 30, 1914 TO 1918, BY ORDER OF MAGNITUDE IN QUANTITY IN 1918.

Article.	1914	1915	1916	1917	1918
Mineral oil..... M gallons..	791,137	662,185	871,478	1,078,321	1,403,728
Sugar..... M pounds..	5,066,821	5,420,982	5,333,162	5,372,746	4,903,327
Bituminous coal..... tons..	1,358,002	1,429,608	1,618,539	1,282,790	1,391,535
Pulp wood..... cords..	1,073,023	985,686	979,010	1,016,814	1,172,033
Iron ore..... tons..	2,167,662	1,196,077	1,425,717	1,151,086	837,546
Sulphur ore..... do..	832,134	844,659	1,375,041	935,009	810,075
Wheat..... bushels..	1,978,937	426,469	5,703,078	24,138,817	28,177,261
Copper, ore, matte, etc..... tons..	478,679	369,597	551,619	613,593	559,780
Manganese, oxide and ore of..... do..	288,706	206,859	492,860	656,068	558,018
Printing paper..... M pounds..	562,858	670,101	878,914	984,401	1,204,040
Coffee..... do..	1,001,528	1,118,690	1,201,104	1,319,871	1,143,891
Wood pulp..... tons..	508,360	587,922	507,048	699,475	504,108
Copra..... M pounds..	55,735	96,483	118,569	256,779	507,576
Rice and rice flour..... do..	290,195	277,191	264,324	216,049	456,058
Jute burlaps..... do..	495,861	399,124	384,810	448,184	443,816
Hides and skins..... do..	561,071	538,218	743,670	700,307	432,517
Cocos, crude..... do..	176,268	192,307	243,232	338,654	399,040
India rubber, crude..... do..	131,996	178,068	267,775	333,374	389,599
Wool..... do..	247,649	308,083	534,528	372,372	379,180
Copper pigs, bars, etc..... do..	231,537	152,443	272,539	359,419	362,494
Soya bean oil..... do..	16,360	19,206	98,120	162,660	336,525
Cocoon oil..... do..	74,366	63,135	66,007	79,223	259,195
Zinc ore and calamine..... tons..	18,280	79,814	291,264	262,767	107,324
Lead ore and bullion..... M pounds..	60,187	82,450	81,599	86,066	188,630
Chromate of iron..... tons..	79,842	47,051	107,069	113,226	77,781
Tin..... M pounds..	91,131	96,988	109,866	103,364	151,315
Tin bars, blocks, etc..... do..	100,178	94,865	143,984	137,576	136,519
Fresh fish..... do..	70,074	90,030	104,895	115,614	117,211
Cotton, unmanufactured..... do..	123,347	185,204	232,801	147,062	103,326
Tobacco..... do..	60,107	45,765	48,013	46,136	79,367
Spices..... do..	56,574	60,084	82,491	58,516	78,061
Raw silk..... do..	28,595	26,031	33,071	33,969	34,446
Argols or winelees..... do..	39,793	28,625	34,721	23,926	30,267

TONNAGE OF VESSELS ENTERED AND CLEARED IN FOREIGN TRADE.

Because of losses at sea, and especially the employment of vessels by the military forces of the United States, the number of merchant vessels engaged in our foreign trade shows a decrease in comparison with previous years. The tonnage cleared for foreign countries during each month of the last year is less than for the corresponding months of the preceding year, and shows a reduction from 52,000,000 net tons for 1917 to 46,000,000 net tons during 1918.

The greater portion of our water-borne foreign trade was, as usual, carried in British vessels, but it is interesting and most gratifying to note that the part carried by American vessels is steadily increasing. During the last year 27.8 per cent of our water-borne imports was carried in American vessels, as compared with 11.4 per cent in 1914.

The percentage of exports carried in American vessels was 19.1 in 1918, as against 14.7 in 1917 and 8.3 in 1914.

The tonnage clearing from the United States under the American flag was 41.9 per cent of the total during 1918, 36.8 per cent during 1917, and 25.8 per cent during 1914.

TONNAGE OF VESSELS, IN NET TONS, CLEARED FROM THE UNITED STATES FOR FOREIGN COUNTRIES DURING THE FISCAL YEARS ENDED JUNE 30, 1914 TO 1918, BY MONTHS AND GRAND DIVISIONS.

Month and geographical division.	1914	1915	1916	1917	1918
	<i>Net tons.</i>	<i>Net tons.</i>	<i>Net tons.</i>	<i>Net tons.</i>	<i>Net tons.</i>
July.....	5,709,984	5,621,051	5,258,066	5,641,050	5,151,959
August.....	5,511,525	4,604,154	5,039,371	5,833,771	5,338,264
September.....	5,260,453	4,422,664	4,737,544	5,082,715	4,635,525
October.....	5,288,630	3,916,146	4,825,489	4,430,905	4,401,907
November.....	4,394,754	3,361,617	4,471,325	4,158,722	3,943,966
December.....	3,664,404	3,128,428	3,804,000	3,767,399	2,966,689
January.....	3,465,247	3,006,229	3,251,919	3,583,496	2,631,274
February.....	2,845,486	2,980,129	3,184,388	2,796,024	2,268,666
March.....	3,516,353	3,180,690	3,401,869	3,321,753	3,017,413
April.....	3,734,939	3,824,151	3,844,768	3,832,568	2,981,907
May.....	4,407,237	4,101,329	5,237,597	4,423,256	4,338,396
June.....	5,184,397	4,738,000	5,365,172	5,105,412	4,327,696
Total.....	53,183,409	46,885,068	52,423,008	52,077,070	46,013,982
Europe.....	20,046,191	18,659,801	19,926,544	18,884,924	14,264,286
North America.....	28,311,006	24,102,286	26,948,101	27,710,761	27,181,621
South America.....	2,429,650	1,943,266	2,707,712	2,772,810	2,237,976
Asia.....	1,277,301	1,091,448	1,620,406	1,586,064	1,550,207
Oceania.....	752,804	650,257	753,834	597,927	544,243
Africa.....	406,457	438,030	466,411	524,584	235,649

PRICES.

It is a well-understood fact that the increase in the aggregate values of our foreign commerce no longer accurately indicates the increasing volume of that trade.

The prices of practically all articles entering into our foreign commerce continued to advance during the year, until in some cases they were three or four times those of former years, and this accounts for a portion of the augmented values. The average export price of upland cotton was 12.8 cents per pound in 1914, 8.5 cents in 1915, and 28.7 cents in 1918, and during the month of January, 1918, was 33 cents. Average export prices of the following articles show notable increases from 1914 to 1918: Cottonseed oil, from 7.2 cents per pound to 18 cents; corn, from 75 cents per bushel to \$1.84; wheat, from 95 cents per bushel to \$2.37; wheat flour, from \$4.61 per barrel to \$11.19; steel billets, from \$22.22 per ton to \$53.66; bacon, from 13.3 cents per pound to 27.2 cents.

The advance in prices on the import side is also apparent in food-stuffs and manufacturers' materials, there being large increases in the prices of sugar, fish, fruits, nuts, flax, wool, manila hemp, sisal, hides and skins, and silk.

SPECIAL FEATURES OF THE BUREAU'S ACTIVITIES.

GERMAN TRADE.

Two reports of outstanding importance were issued during the year on German trade, the first entitled "German Foreign-Trade Organization" and the second "German Trade and the War." These resulted from extended studies by Chauncey D. Snow, Assistant Chief of the Bureau, and were aimed, first, to set forth the actual facts as to Germany's machinery for carrying on foreign trade at the

time war broke out and her methods of penetration, and, second, to throw light on the subject of Germany's war-time commercial and industrial conditions and their bearing on the future trade of the country.

These are subjects that have been widely discussed ever since the war started, and there has naturally been some confusion as to the facts. Mr. Snow has handled with an open mind such subjects as the organization of German commercial education, the promotion of trade by German settlements in foreign countries, the German banking and shipping facilities, the character and extent of the foreign trade of the country, and the raw materials and imports. The evil in the mental attitude of the German commercial community and the good and bad points in German methods are pointed out impartially for the benefit of our own business communities. The detailed statistics of Germany's trade have been widely studied, as correspondence and press quotations prove. It is felt that these two reports have had and will have important results in preparing the country for the part it is to play in world trade after the war. Valuable assistance in preparing the statistics in both volumes and the text of the report on "German Trade and the War" was rendered by J. J. Kral, of the research division of the Bureau.

CENSUS OF CHEMICAL IMPORTS.

In the preparation for industrial and commercial readjustments after the war the Bureau has done nothing that will have more far-reaching and beneficial results than its work of preparing an adequate census of this country's imports of chemicals during the fiscal year 1913-14. The plan to carry out this census was worked out at the suggestion and in cooperation with the American Chemical Society some time previous to last year, but it was only during the last 12 months that much effective practical work was accomplished. At the close of the year an adequate force furnished by the Bureau was at work in the New York customhouse under the direction of Dr. E. R. Pickrell, chief chemist of the United States appraisers' stores of the port of New York, and indications were that copy would be ready for the printer by December, 1918.

This has been a tremendous undertaking, as is evidenced by the fact that more than 20,000 invoices of chemical imports have been segregated from 500,000 general invoices from more than 100 ports of entry in the United States and possessions. It is expected, however, that the practical results from the publication of this material will be beyond computation and will be a most important factor in the development of a well-rounded and self-contained chemical industry here in the United States. The exact details of our previous dependence upon European—largely German—sources of chemicals should prove just as valuable as did similar details concerning the imports of dyestuffs, published in 1916 by this Bureau. The Bureau has been assured by manufacturers and technical men in a position to know that the recent growth of the American dyestuff industry was based upon the exact information presented in the dyestuff report.

The use to which the chemical census will be put is indicated in the following extract from the report of Dr. Bernhard C. Hesse, chair-

man of the American Chemical Society committee to cooperate with the Bureau of Foreign and Domestic Commerce in obtaining statistics on foreign trade in chemicals in 1913-14:

I have made tentative plans for the elucidation of these statistics and for their periodical appearance in the future, but without definite commitments on the part of the American Chemical Society or the various Government agencies consulted. These plans are all based upon preparation by the American Chemical Society for an analysis of these 4,000, or thereabouts, entries, showing for the manufactured and semimanufactured articles the raw materials (mineral, vegetable, and animal), and the approximate quantities of each, entering into their production.

The Geological Survey will then prepare a succinct statement as to the location and production of the mineral raw materials, and Dr. Carl L. Alsberg, Chief of the Bureau of Chemistry of the Department of Agriculture, has offered to enlist that department's cooperation through its various bureaus for similar treatment of the vegetable and animal raw materials. The Tariff Commission has been approached for its cooperation in listing the industrial and commercial uses of each of these 4,000 entries.

With such a compilation as an appendix to the statistics now approaching completion, it should be possible dependably and rapidly to ascertain for any manufactured product the amounts imported, what raw materials and their amounts were needed, what uses it has in the arts, and also for any given raw material information as to what finished or semifinished products made from it were imported, their industrial uses, and the respective amounts of all and each.

Domestic production of raw materials for the chemical industry, semifinished and finished chemical products, should be greatly stimulated and its growth intelligently directed through such a compilation, the successful making of which is beyond the strength of any one man or group of men, as has been conclusively demonstrated by occasional abortive efforts abroad. I have also considered compiling information of similar scope and character for our exports and for our domestic production, and have concluded that for the present, at least, such is not only unnecessary but without merit, for these would only confuse, since they do not show the extent of our dependence.

THWARTING GERMAN COMMERCIAL PLOTS.

In most of the neutral countries German agents are obliged by circumstances to confine themselves to commercial plots and intrigues and underhand propaganda, and as they are past masters at that sort of thing it has been necessary to watch them very closely. In its commercial attachés and traveling special agents the Bureau happily has had a corps of just the right kind of men for the work, without the necessity of taking their attention wholly from their usual tasks. They inevitably, in pursuit of their own commercial investigations, cross the trail of commercial plotters of Teutonic origin or sympathies. If German agents in some Latin-American country, for instance, are seeking by misrepresentation and intrigue to discredit American electrical goods and houses in an effort to keep the market safe for German manufacturers after the war, the Bureau's agent studying electrical markets in that district is sure to bring the whole matter to light. In one South American country the American commercial attaché brought up with a turn a campaign of disparagement and calumny directed by Germans at the hosiery trade of the United States. The attachés, being on the ground all the time, are in a very advantageous position to report on such matters. Information obtained in this way has been of prime importance to the various war organizations of our Government and has enabled the Bureau to anticipate German plans for the future.

TRADE-MARK PIRACY.

German attempts to register trade-marks in foreign countries, particularly in South America, were reported to the Bureau at intervals during the last year. Our procedure in cases of this kind is the same as in any other attempt to appropriate trade-marks belonging to American concerns—that is, the American firms are notified that trade-marks belonging to them have been offered for registration, and they are advised how to proceed to maintain their rights. Regulations governing the registration of trade-marks vary in different countries. In the United States the person who first uses a mark is considered the owner even if he does not register it promptly. In some South American countries the man who first registers the mark is the owner. It is easy to see how serious it would be to have any considerable number of American marks pass into German hands in these markets. Some marks have been definitely lost, but others have been reregistered upon proof of fraud on the part of the original registrant, and steps have been taken with the Governments of the countries involved to prevent the German practices and restore American concerns to their proper position.

PAN AMERICAN TRADE-MARK BUREAU.

In February, 1918, the Bureau called to the attention of the United States Section of the International High Commission the desirability of enacting domestic legislation to give effect to certain provisions of the trade-mark convention adopted at the Fourth International Conference of American States at Buenos Aires in August, 1910, particularly that portion of the convention providing for international registration of trade-marks at Habana, Cuba. An informal committee was constituted, consisting of Mr. Whitehead, the First Assistant Commissioner of Patents; Dr. McGuire, of the United States Section of the International High Commission; Mr. Carter, representing the Bureau; and Mr. Barber, representing the United States Trade-Mark Association. This committee finally agreed on the form of the desired legislation and bills were introduced in both Houses of Congress July 1, 1918.

AMERICAN LINEN INDUSTRY URGED.

The Bureau has for years taken an interest in the possibility of developing an American linen industry. In 1913 a commercial agent of the Bureau made a comprehensive investigation of linen manufacturing in Ireland and Scotland. In 1916 a special report on "Development of an American Linen Industry" was published by the Bureau. That report was not optimistic either as to the probability of the development of flax growing or the development of a fine fabric industry. In 1917 the Bureau again took up this question, partly in an effort to help meet war demands.

Linen has a multitude of war uses, the most conspicuous of which have been the aeroplane fabric and linen thread for shoes, etc. For a long time it was believed that linen was the only fabric that could be used for aeroplane wings. Largely by experiments made in the

Bureau of Standards of the Department of Commerce, however, it was proved that a special fabric could be made of high-grade cotton which would serve the purpose, and such fabric is to-day as a matter of fact being used in American aeroplanes. Similarly in the case of thread there has been successful substitution of hemp and other fibers. Whereas in Great Britain the linen aeroplane fabric is still regarded as indispensable, in the United States the demand for linen and linen products has been largely met, and satisfactorily met, by cotton and other fibers.

The Bureau of Foreign and Domestic Commerce has taken up the question of flax production in the United States with the textile experts of the Department of Agriculture, the United States Tariff Commission, the Bureau of Standards, and some of the leading flax growers and treaters. Our country is a big factor in producing seed flax, but not fiber flax. In the world's fiber flax market Russia has for long occupied very much the same position as the United States has occupied in the world's cotton market. The flax region of northern France and Belgium has also been very important. At present the customary production of flax in Europe is entirely deranged and it looks as if for a long time to come there will be a distinct shortage of flax fiber. In England, in Ireland, in Canada, and in Japan flax acreage has increased. In the United States there has not been a great increase. A few thousand acres are grown, the principal region being that in Michigan, with other flax for fiber being grown in Oregon, Montana, and a small acreage in some of the other States of the Northwest.

It has now been demonstrated that it is possible to treat flax from the straw to the tow and line stage successfully on a factory basis in this country. The climate and the soil in several parts of the States are adapted to flax culture. The farmers in the Michigan section and in some of the other flax sections know how to grow fiber flax, and the acreage is capable of great extension. There seems to be no good reason why flax should not be grown widely in the South. With the present shortage of flax fiber, and the prospective shortage, it looks as if the American textile mills can take, at good prices, all the flax which the flax mills can turn over to them. The war has created a situation where the American flax and linen industry has an opportunity to develop if it is ever going to. Nevertheless, in view of the good prevailing prices for the food crops, flax acreage here has not yet developed to the full extent which the present opportunity seems to justify.

The Bureau has been endeavoring to keep the American interests informed as to foreign conditions and has met with enthusiastic response in its endeavors to help the extension of the linen industry in certain quarters, but there is a certain amount of apathy, and there continues to be in certain quarters distinct skepticism as to the probability of the development of the linen industry here to any great extent. The American linen-thread industry is of course carried on on a very large scale. At least one concern has very successfully manufactured linen fabrics. The pulling of flax in the field still offers labor difficulties, but the American manufacturers feel that this is a mechanical question which can be met. There have been improvements in the retting and scutching processes in this

country. It is stated by those in the industry that there is no reason why flax spinning and flax weaving should not be successfully carried on here. The use of the automatic loom on linen fabrics solves some of the labor difficulties.

This is a somewhat peculiar condition for an American industry—with all the well-known success of this country in handling both agricultural and textile manufacturing questions, it would seem that there is no reason why an American linen industry should not develop and thrive. The present world shortage of the high-grade textile fibers lends itself to such a development. It will take capital and energy, and it is a distinct challenge to American business. If the existing apathy can be overcome and the agricultural end met, there is no doubt that the industrial end will keep up. We have high hopes for an American linen industry which can be developed right along the lines on which it has started in this country. The Bureau of Foreign and Domestic Commerce will continue its efforts to encourage this development. It seems as if the first big step toward a well-rounded American linen industry must be large-scale development of flax production within our own borders.

DEVELOPMENTS IN THE PLATINUM SITUATION.

Immediately upon our entrance into the war, it was brought to the attention of the Bureau that there was probably an insufficient supply of platinum in the country to meet needs that would be sure to arise in connection with the manufacture of munitions.

The jewelers of the country, acting through the Jewelers' Vigilance Committee, and desiring to do what they could to help meet the Government's needs, voluntarily adopted resolutions looking toward the conservation of platinum in the jewelry industry. It was also agreed by the committee and the Bureau that an exact knowledge of the amount of unmanufactured platinum in the country would be valuable, and the Geological Survey completed the taking of such a census in June, 1917. To supplement this an international search for available supplies of platinum was started by the Bureau in April, 1917. Evidences of domestic deposits which came to the attention of the Bureau as a result of this search were referred to the Geological Survey of the Department of the Interior for further investigation. It was ascertained in May, 1917, through the commercial attaché in Petrograd, that although the production in Russia was greatly under normal on account of labor shortage, there was a certain stock in Ekaterinburg which would be augmented by a production in 1917, some of which could no doubt be obtained for our war needs. This was brought to the attention of (1) the Committee on Raw Materials, Minerals and Metals of the Advisory Commission of the Council of National Defense, (2) the Geological Survey, (3) the Bureau of Mines, and (4) the Bureau of Standards.

On June 19, 1917, a meeting of the prominent platinum refiners of the country was held in the Bureau and a committee was selected to represent these refiners in negotiations with the authorities of the Allied Nations, looking toward the procuring for and distribution in this country of supplies of platinum. In August, our commercial attaché at Petrograd advised us that a consulting engineer there desired to export crude platinum to the United States, the distribution

and price to be controlled by the Department of Commerce, the financing to be taken care of by a bank in Russia with an agent in the United States. Before the commercial attaché could be advised of our wishes in the matter he cabled us again stating that because of a rumored 70 per cent increase in the price of platinum he had arranged to procure an export license from the Russian Government for platinum, which would come consigned to the Secretary of Commerce. The President authorized the Secretary of Commerce to receive the same and to transfer it to the chairman of the Committee on Raw Materials. When the shipment finally arrived it was allowed to come in bond from San Francisco to New York, where it was taken over by the War Department at the suggestion of the Committee on Raw Materials. In April, 1918, the Bureau definitely withdrew from the platinum negotiations in favor of the Procurement Division of the Ordnance Department and the War Industries Board.

TIN IMPORTS.

At the beginning of the fiscal year the commercial adviser of the British Embassy in Washington was advised of our desire to make some arrangement with his Government under which sufficient quantities of British-controlled tin to supply the requirements of our trade would be released monthly and distributed in this country through the American Iron and Steel Institute, under the guidance and control of the Department of Commerce. A plan to control the use and distribution of all British tin imported into this country was prepared and approved by the Solicitor. Before it could be approved by the Department, the Executive order creating the Exports Council and vesting in that body the control of foreign trade was signed by the President. In the meantime, Commercial Attaché Williams, in London, with the assistance of Mr. Sheldon, representing our Food Administration there, continued to represent the interest of our consumers, both as a whole and in individual cases, before the British Rubber and Tin Exports Committee. Finally, in October, the War Trade Board, successor to the Exports Council, received authority of law to control imports, and in November regulations for controlling this importation, as well as the distribution of tin in this country, after being agreed upon by the War Trade Board, the Food Administration, and a representative of the Bureau, were promulgated by the War Trade Board.

From this time on the actual tin negotiations with Great Britain were conducted for our Government by the War Trade Board. Great Britain finally agreeing to allocate to us a certain amount of British tin each month. It was also agreed that all shipments of Straits and Australian tin should henceforth come to us via the Pacific instead of via London.

In February the War Industries Board assumed control over the importation and distribution of pig tin and, with the assistance of the Bureau of Standards, took up the question of greater economy in the use of tin, a subject to which this Bureau had already given attention with gratifying but not sufficiently universal results. Our commercial attaché in London, notwithstanding the many changes in control of the tin situation here, has remained in charge of the London end of our negotiations respecting this commodity.

STATISTICAL PREPARATION FOR AFTER-WAR TRADE.

The Bureau has undertaken careful statistical studies of the normal world markets for important lines of merchandise, the object being not to promote present trade so much as to enable American manufacturers to prepare themselves for trade after the war. The first study published was devoted to the quantities, values, and sources of furniture imported by countries whose transactions exceeded \$500,000 in value. It is issued under the title "Furniture Imports of Foreign Countries." It is planned to issue a series of similar studies of other lines as rapidly as they can be prepared. The Bureau is organizing to render a decidedly wider range of statistical service, both with reference to the statistics of foreign countries and the statistics of the United States.

NEW PLAN TO STIMULATE FOREIGN TRADE.

A novel method of Government trade promotion was inaugurated during the year when the Bureau issued the first of a series of Spanish-English pamphlets defining with scientific accuracy certain generally accepted American industrial standards for construction materials. The first pamphlet issued is entitled "Standard Specifications and Tests for Portland Cement," and was prepared by the American Society for Testing Materials, in cooperation with the American Society of Civil Engineers, the Bureau of Standards, the Bureau of Foreign and Domestic Commerce, and the Office of Public Roads. This will be followed by a long series, principally iron and steel, all of which were in press at the close of the year.

The publication of this series is aimed to facilitate American trade with the Latin countries, but it is not in any sense an attempt to force American standards upon them. The standards of the American Society for Testing Materials are already known and used in these countries, and the decision to publish them in Spanish was reached as a result of numerous requests from the Latin countries for just this sort of information. Great care was taken to make the translations thoroughly idiomatic as well as technically correct.

PROMOTING COMMERCE WITH MOTION PICTURES.

The Bureau has given considerable thought to the feasibility of using motion pictures to acquaint the people of other countries with American goods and manufacturing methods. Considerable success has apparently been attained by the Canadian Government in using this method of calling attention to the Dominion's great resources and its advantages to the investor and settler. In England the advantages of the motion picture in promoting foreign trade have been discussed at great length and a private company has been organized to carry on the work in cooperation with British chambers of commerce in various parts of the world. The Bureau has tried out the plan on a small scale by supplying the commercial attaché in China with a projector and films, and the evidence seems to be rather conclusive that the Government could take up the work on a large scale and carry it on efficiently, economically, and to everybody's satisfaction. It is safe to say that within a short time after peace is made the motion picture will be used by all the great manufacturing coun-

tries to promote the sales of their wares, and certainly the United States, the home of the motion-picture industry, should make its plans to meet the competition.

FOREIGN-TRADE EDUCATION.*

Unprecedented interest is being manifested in the educational preparation of Americans for foreign trade. It has always been one of the difficulties which American concerns entering the export trade have had to encounter, to find suitably trained men to travel abroad, make up the staff of a foreign office or branch establishment, or handle the export end of the business in this country. Undoubtedly there have been more young Germans, young Englishmen, Frenchmen, Hollanders, possibly also even Swiss, who have been ready and anxious to take up the export trade. Many of our liveliest concerns have worked painstakingly on this problem, only to be compelled to a very considerable extent to rely on foreigners for this service. In the British press at the present time the shortage of British youth and the inadequate facilities for the training of British youth for foreign trade are much deplored. In Germany the need of training men for foreign service is being emphasized more than ever before. In France the subject is again being agitated in lively fashion. The liquidation of German houses in allied countries has shown that even Germany had had no little difficulty in staffing its foreign-trade establishments. We have perhaps been inclined too much to the view that the other manufacturing nations were perfectly equipped in this particular respect while we were inadequately equipped. It now appears that the United States was not alone in this state of unpreparedness for foreign trade, although clearly behind its principal competitors.

Interest in foreign commerce in the high schools of commerce, in colleges, in collegiate schools of business, the Y. M. C. A. schools, and other night schools, has been on the increase in the past four years, and the increase of late has been sharp. One correspondence school in New York has issued a 12-volume course in foreign trade which has had a large following. Some of the other well-known correspondence schools specializing on business courses have got out special reports and bulletins on export trade, ocean shipping, etc. Our foreign-trade literature is growing rapidly in books, magazines, and newspapers. Interest in foreign language courses has been tremendously uplifted both because of this growing interest in foreign commerce and because of the war. Foreign language texts, foreign language classes in the schools, private language classes and correspondence-school courses in foreign languages have been multiplied.

The Bureau of Foreign and Domestic Commerce has been in close touch with this educational development and has constantly contributed to give it impetus. The publications of the Bureau have been one of the leading means of instruction in the various aspects of foreign trade. The National Foreign Trade Council, the Chamber of Commerce of the United States of America, the American Manufacturers' Export Association, National Association of Manufacturers, the Philadelphia Commercial Museum, the Boston Chamber

* This section on commercial education, written by Mr. Snow, is from Commerce Reports of Sept. 9, 1918.

of Commerce, the New York Merchants' Association, the Philadelphia Chamber of Commerce, the Chicago Association of Commerce, the San Francisco Chamber of Commerce, and a large number of other commercial associations and the various educational associations have all encouraged this interest in studies preparing for foreign trade and have helped it along. The discussions at the second Pan American Scientific Congress in the winter of 1915-16 cleared the air a bit. The Bureau of Foreign and Domestic Commerce has assisted the professors and instructors in the schools in shaping their foreign-trade courses and in mapping out their syllabuses and lists of foreign-trade readings. The Bureau of Education in the United States Department of the Interior has naturally been closely identified with the spirit of interest in foreign-trade education. The Commissioner of Education, Dr. Philander P. Claxton, personally has helped the movement along; the specialist in commercial education of the Bureau of Education, Dr. Glen L. Swiggett, has for considerable periods of time given practically exclusive attention to this pressing aspect of commercial education. Under the auspices of the Commissioner of Education conferences have been called and eminent working and advisory committees appointed for this purpose. The Bureau of Education has surveyed the principal trading centers and has appointed local committees to look out for the interests of foreign-trade education. The Bureau of Foreign and Domestic Commerce is cooperating with the Bureau of Education in this important movement both in Washington and throughout the country in the cities where its local district offices are situated. This is promoting foreign trade in a vital quarter.

Most significant is the fact that the recently organized Federal Board for Vocational Education took up the subject of education for foreign trade as one of the fundamental lines for practical application at the present time in preparation for trade after the war. The board has gone into this subject in a very practical manner and will be in a position to render most valuable service to the numerous new foreign-trade classes which are organizing this fall. In the board F. G. Nichols, the well-known specialist in educational training, and Dr. Roy S. MacElwee, formerly of Columbia University, who brought to his teaching in that institution a combination of many years of actual selling experience abroad and a wealth of information on ports, shipping, and transportation, are directing this practical vocational work in connection with foreign trade.

The Federal Board for Vocational Education and the Bureau of Foreign and Domestic Commerce are combining in getting out a manual of readings on foreign trade which is prepared to bring together in one volume the best things which the consuls, commercial attachés, special agents, trade commissioners, and business men of the United States have written and said on the whole subject of foreign trade. In 1917 the Bureau got out a little book of "Export Trade Suggestions," in which pointers by consuls and others were given as to the conduct of business abroad. That monograph was a decided success and was welcomed by all interested in foreign trade. The new publication is being prepared by Dr. Guy Snider, of the College of the City of New York, who has conducted courses in foreign trade in New York primarily for the benefit of the clerks and

minor officials in concerns doing foreign business. The monograph will incidentally serve the purpose of a text for new and old classes in foreign trade as well as providing a very solid manual for the use of the business man.

Another piece of work which the Federal Board for Vocational Education has now in the course of preparation is a carefully classified collection of the documents used in foreign trade. This will give, step by step, for the various sorts of foreign-trade transactions, the actual documents in use in typical American concerns. Again, the practical vocational aspects of foreign-trade transactions are kept constantly in view.

COMMERCIAL ATTACHÉS.

There still exists among business men some confusion as to the coordination of the functions of the commercial attachés with those of our diplomatic and consular officers. The lines of demarkation, however, are fairly clean cut. The legislative act creating the position of commercial attaché prescribes that they shall be appointed by the Secretary of Commerce, after examination to be held under his direction to determine their competency, and be accredited through the State Department, and that their duties shall be to investigate and report upon such conditions in the manufacturing industries and trade of foreign countries as may be of interest to the United States. Shortly after the inauguration of the service, the Department of State, acting in harmony with the Department of Commerce, issued General Consular Instructions No. 397, dated April 5, 1915, explaining the character of the attaché's work, as follows:

The Secretary of Commerce in his latest annual report has appropriately distinguished between the various classes of officers engaged in the promotion of trade abroad by describing the commercial attaché as an officer whose duty it is to maintain a general outlook over trade in the country within which he is stationed; the consul general or consul as an officer with a fixed post and charged with the duty of maintaining a local outlook over the trade of the consular district; and the commercial agent as a traveling officer with a single subject or group of subjects for investigation and who is not restricted in his studies to any one country. It will thus be seen that the officers of each class have their special field, and it is believed that they should be able to find therein full opportunity for the employment of their activities.

NEW APPOINTMENTS AND TRANSFERS.

There were several changes in personnel at our various posts during the past year. Commercial Attaché Williams returned from London in the fall of 1917, and, after acting as liaison officer for this Department and as adviser to other Government departments, he was detailed to Paris to assist Mr. George McFadden, the representative in France of the War Trade Board. Commercial Attaché Veditz at Paris returned to the United States in March, and Mr. Williams was made commercial attaché at this station on April 1, 1918. Commercial Attaché Kennedy left Melbourne in the fall and was appointed commercial attaché at London on January 1, 1918. P. L. Edwards was promoted from secretary to the commercial attaché at The Hague to commercial attaché at The Hague on January 1, 1918. Special Agent Robert S. Barrett, after completing

his investigation of the paper and printing-machinery markets of South America, was appointed commercial attaché at Buenos Aires on February 4, 1918. The accrued vacation leave of Commercial Attaché Verne L. Havens terminated on July 31, 1917, when the office at Santiago, Chile, was discontinued. Trade Commissioner A. W. Ferrin, who was making a study of banking and investment conditions in the Far East was appointed commercial attaché on February 1, 1918, and assigned to Melbourne. During the balance of the fiscal year Mr. Ferrin was detailed to Peking, where he remained in charge of the office during the absence of Commercial Attaché Julean H. Arnold, who was acting as the chairman of the Maritime Customs Conference Meeting at Shanghai.

Regarding the secretaries to commercial attachés, J. F. Butler was transferred to Paris in March, and Z. C. Oseland was appointed secretary to the commercial attaché at London on January 25, 1918. The accrued vacation leave of A. F. Graffam, of the Paris office, terminated on March 25, 1918. Henry Wasserman resigned his position at Lima on August 18, 1917. Robert E. Hurd was appointed as his successor on March 11, 1918. William F. Smith was transferred from our Melbourne office to Washington, arriving on July 6. He was succeeded at Melbourne by Howard A. Treat, who was appointed on July 20, 1917. A. L. Hill, secretary to the commercial attaché at Tokyo, returned to the United States and was transferred to the Chicago district office on February 1, 1918, when he was succeeded by Mr. Mochizuki.

In Washington, Eliot G. Mears, formerly chief of the division of commercial agents, was transferred to the position of chief of the commercial attaché division. William F. Smith, formerly secretary to the commercial attaché at Melbourne, returning to Washington, was appointed to this division.

BETTERMENTS IN THE COMMERCIAL ATTACHÉ SERVICE.

Three important features of the past year's work have been: Firstly, improved working relations with other Government departments; secondly, the securing of an appropriation for the purpose of compensations for increased cost of living; and, thirdly, closer attention paid to the personnel of the commercial attaché's clerks.

The broad scope of the attaché's work, namely, the whole field of commercial, industrial, and financial questions relating to his special territory, naturally makes his reports of decided interest to many departments other than the Department of Commerce. Data dealing, for instance, with Germany's post war plans, the importance of Copenhagen as a trade-distributing center, food conditions on the Continent, the exchange situation in China, are useful to at least a dozen Government bureaus. It was, therefore, early found desirable to require commercial attachés to submit several copies of reports that might be referred to other departments, and a transmittal form was prepared allowing for such reference in the simplest and quickest fashion. The amount of this material useful to other departments has been considerable, and the natural result of this working arrangement has been a closer touch between our department and other departments, both at home and abroad.

Our attaché service has not yet reached a point where the remuneration allowed by law is sufficient to meet the social and ordinary living expenses in foreign countries. As a member of the diplomatic staff, our representatives must be prepared to observe the usual social requirements pertaining thereto. The salaries (with the allowances now possible) to commercial attachés, although increased during the past year in five instances, are still inadequate. We were fortunate in securing from Congress an appropriation of \$9,000 to be used as a post allowance to employees in the attaché service resident abroad to enable them to reduce materially the expenses formerly paid from private funds. The increased cost of living abroad is more than a by-word; it is a serious problem confronting the future of the service. Among the posts which have suffered greatly for this reason during the past year have been Buenos Aires, Petrograd, and Peking.

We have not forgotten the part played by the clerks to commercial attachés, whose services are always in demand, and who must assume the entire charge of the offices during the absence of the commercial attachés while traveling in the United States or away from their immediate posts. Strictly high-grade assistants are hard to find. It is a satisfaction to report that the lot of these men has been improved during the past fiscal year in two ways—through promotion to the position of agents and through increased compensation.

Our problem is primarily one of collecting and retaining in our service the best men available, and the various steps taken during the past year should help to stabilize our foreign service.

WAR WORK OF COMMERCIAL ATTACHÉS.

The activities of the attachés that may be considered war work may be classified as follows: The furnishing of business data, formal designation by other Government departments, special assignments by other Government departments, and especially the cultivation of international good will abroad.

FURNISHING OF BUSINESS DATA.

While the United States was at peace, the commercial attachés were regarded primarily as trade-promotive agencies, keeping a close watch on significant commercial developments in the territories to which they were assigned. It was nevertheless necessary after our entrance into the war to have them center their attention more strictly on important economic developments which would aid in the building up of our Government information files. Reliable information regarding Germany, for example, was at a premium. As trade restriction increased at home and abroad, the attachés were less concerned with immediate promotive work and gave increasing assistance in securing raw materials and supplies for the use of our Army and Navy and essential industries. During the last year the commercial attachés have been conspicuously active in procuring optical glass, platinum, manganese, and tin. The commercial attaché at Paris has been of material aid to the American Expeditionary Forces. The commercial attachés at London and elsewhere have demonstrated the value of reports by business specialists.

DESIGNATIONS BY OTHER DEPARTMENTS.

The commercial attachés, appointed by the Secretary of Commerce and accredited through the State Department, must ordinarily give every moment of their working time to these departments in order to keep us properly informed. Owing, however, to the need of well-informed and well-equipped commercial men in other departments, at times some of the regular commercial assignments have been postponed in order to render the greatest service to the country. Every one of the commercial attachés is regularly doing a considerable amount of War Trade Board work. In two cases they are acting as representatives of the War Trade Board, and in others they have been handling special assignments on commercial war work. Commercial Attaché Barrett is a representative of the board in Argentina, and late in the fiscal year was also given complete charge in enemy-trading matters. Commercial Attaché Edwards is a representative of the board in Holland, and is sitting on the Interallied Joint Council, which meets regularly at The Hague. Commercial Attaché Montavon has been acting as chairman of the subcommittee of the Allied Conference of Ministers, at Lima, which considers points of common interest with regard to war-winning activities. It may be mentioned that it was at the suggestion of our commercial attaché that there was organized by the committee a conference at Lima of the heads of diplomatic missions of the countries associated with us in the war. This conference has met weekly in his office. Commercial Attaché Thompson was needed in London by the War Trade Board as an expert adviser on continental trade, and he spent the last four months of the fiscal year there, especially in connection with the Danish and Dutch negotiations. Commercial Attaché Kennedy, at London, has been handling for the War Trade Board for the past few months certain questions relating to minerals and rules and regulations of exports from the United States. Commercial Attaché Barrett is also acting as the representative of the United States Shipping Board at Buenos Aires and submits regular reports on shipping conditions. Mr. Barrett is also a special representative of the War Industries Board at Buenos Aires and Montevideo.

Aside from the customary diplomatic work for the benefit of our embassies and legations, two of our commercial attachés have had important special assignments given them by the State Department. Commercial Attaché Huntington, who speaks Russian fluently, was a general utility man in Russia. At the close of the fiscal year he was a resident at Moscow, where he was working in close relation with the diplomatic and consular officers. Commercial Attaché Arnold was designated by the State Department to act as chairman of the International Maritime Customs Conference Meeting at Shanghai. This conference was attended by the representatives of 14 nations, whose purpose it is to raise the Chinese tariff to an effective 5 per cent, in accordance with the provisions of the Boxer agreement.

SPECIAL WORK FOR OTHER DEPARTMENTS.

The War Department, Navy Department, State Department, War Trade Board, Shipping Board, Food Administration, War Industries Board, Tariff Commission, and the Departments of Agriculture and

Labor have been among those that have called upon us for information regarding which we have cabled our commercial attachés.

Possibly the part played by the Department of Commerce through the commercial-attaché service can be indicated most clearly by citing the number of communications received from commercial attachés and distributed to other departments in Washington. During a single month, that of March, copies of 154 communications received from commercial attachés were forwarded to other Government departments as follows: War Trade Board, 46; State Department, 24; Shipping Board, 18; Food Administration, 17; Department of Agriculture, 15; Treasury Department, 14; War Industries Board, 6; Tariff Commission, 6; Bureau of Public Health Service, 2; Department of Labor, 2; and 1 each to the Federal Trade Commission, the Post Office Department, Bureau of Public Information, and the International High Commission.

Commercial Attaché Arnold, while at Shanghai in connection with the customs conference, acted as field representative of the American Red Cross, and was very successful in establishing branches and securing members and subscriptions during this period. He established live Red Cross chapters at the following places: Shanghai, Canton, Hongkong, Swatow, Amoy, Foochow, Nanking, Hankow, Chinkiang, Peking, Chefoo, and Tientsin. Mr. Montavon, at Lima, was also a member of the local executive Red Cross committee.

ADJUSTMENT OF TRADE DIFFICULTIES.

The unselfish motives of the United States in entering the war have not always been properly understood abroad. Foreign business houses dealing with American manufacturers and exporters have been constantly vexed because of the failure to secure export licenses and at the slow delivery and rapidly changing prices. The attachés have rendered an immeasurable service in taking up individual cases with annoyed merchants and in endeavoring to make the people understand that our commercial enterprises have yielded willingly to important war demands. A well-known American importer on the west coast of South America, who was somewhat annoyed at his failure to receive what he regarded as necessities, made a visit to the United States, and on returning stated to our commercial attaché that it was difficult for him to do any business at all here. He remarked that the United States did not seem to be interested in anything but winning the war. The work of our attachés in this regard has had a decided educational value which should mean much to our future trade. The Bureau's machinery for handling trade misunderstandings depends to a considerable degree upon the attaché service. As an illustration, the commercial attaché at Lima states that during the year he has adjusted nine complaints between the American exporters at Lima and Callao customs officials. In every one of these cases he has personally been successful in securing the recognition of the position of the American business firm, and he has enabled American exporters to avoid the payment of unnecessary charges.

TRADE PROMOTION.

This year the chief promotion work of the commercial attachés has been to see that the channels of trade are kept open and to suggest the names of desirable agents to handle American goods after

conditions become normal. The lack of tonnage and the conservation of materials and supplies and labor at home have dealt our export trade a hard blow. All of our chief competitors, however, are experiencing similar conditions; it would be out of place for commercial attachés to be concerned about furnishing immediate trade opportunities. Early in the fiscal year, however, when trade was not so seriously interfered with, most of our attachés were able to report several instances of successful trade promotion. For example, the commercial attaché at Peking reported that, at his suggestion, a representative of an American firm visited China and in a short while secured the entire business in a certain line which had previously been held exclusively by Japanese firms.

Another case was that of our commercial attaché in Australia, who was asked by the committee in charge of Australian leather to assist in finding a market for their product which had formerly been exported to England. Samples were secured from a large number of tanners through the assistance of the Australian Customs Department. These samples were exhibited at branch offices of the Bureau. Supplementary information regarding prices, terms, etc., was also submitted, with the result that a large quantity of this leather was later sold and shipped to market.

CULTIVATING INTERNATIONAL GOOD WILL.

The sympathetic interest of our attachés for assisting in any way the social and industrial interest abroad is illustrated by the energy of our commercial attaché at Peking in promoting an organization which bears the name of the Society for Constructive Endeavor. The object of this society is as follows:

In recognition of the great need of constructive work designed to better the conditions of our people and country, especially so in view of the new industrial and economic era upon which China is now about to embark, it is the object of the society to understand and encourage constructive endeavor in whatever manner may be found practical and effective. The society being non-political will, moreover, refrain from permitting itself to use to advantage the personnel of interest to any members or individuals.

The suggested program of activity includes the following: Reception of foreign visitors, the development and coordination of information about China, the effect of the war on Chinese trade, increased activity and coordination with trade and commercial associations, and the making of surveys on industrial, commercial, and educational facilities. This organization was cordially received by the Chinese and is apparently in position to render unselfish, noteworthy service.

Commercial Attaché Rutter, at Tokyo, reckons as his most important accomplishment during the past year his contribution toward maintaining and improving the favorable business sentiment between Japan and the United States. This sentiment counts for a great deal in the economic cooperation as regards war-trade measures, and promises much for the future development of trade between the two countries. The commercial attaché was one of the valued advisers of the Ambassador in the arrangement whereby delivery of Japanese ships to the United States was arranged in return for shipments of steel. Our commercial attaché at Copenhagen has the confidence of Danish people and has done valuable service in interpreting their feelings toward the restrictions of the Allies. Our commercial attaché

at Lima has been consulted continually by Government officials for advice regarding local questions of trade and commerce. His work has been so successful and so well organized that during the past year the Technical Melbourne Commercial School of Lima selected him for special distinction as the man who had done most for trade education in Peru during the past year and conferred on him the diploma known as Laurel Patriotico. Our commercial attaché at Melbourne, on leaving for the United States en route to his new appointment at London, was given a very cordial send-off by both Government officials and Australian and American business men. On September 4, 1917, a parliamentary luncheon was given by the Victorian State Government at the State Parliament House at Melbourne. Three days later a formal luncheon was accorded him in Sydney by the American business community. The governor of the Commonwealth Bank of Australia was one of the speakers at this luncheon and stated that the commercial attaché had done more to bring about the financial understanding between Australia and America than any American had ever done or could ever do.

The commercial attachés, in a variety of ways, have been successful in explaining the changes in the United States brought about by the war and in demonstrating that in our desire "to make the world safe for democracy" we were often misunderstood and ill judged. The best way to bring about mutual understandings is through personal confidences. It is in this way that our commercial attachés have assisted in establishing the position of the United States with foreign countries during the war.

RECOMMENDATIONS.

The most pressing need is for larger appropriations which will permit us to pay larger salaries (or give larger allowances) to present incumbents and to provide for new posts. We are face to face with the constant danger of having our attachés and their secretaries forced to accept the offers of private firms unless we can establish a more satisfactory scale of compensation. Besides the increased living costs must be considered the declining value of the dollar in certain countries; the most noticeable case is in China, where the rising value of silver exchange has made the dollar worth approximately one-half of its value a year ago.

New attachés should be assigned to a number of important capitals, especially Rome, Madrid, Ottawa, Mexico City, Santiago, Chile, and Athens.

I can not overemphasize the increasing importance in our plan of foreign trade promotion of these resident men in foreign countries. The commercial attaché is a necessity in countries where the more important commercial interests of the United States are constantly coming up for consideration. It is important on both ends of the line; commercial inquiries relating to the broader questions are constantly reaching the Department from our business men. Very frequently prompt investigation and cabled replies are necessary. The only way that this service can be rendered is by having a trained commercial expert in the foreign country who is there for the sole purpose of attending to these commercial matters. In order to attend to them successfully he must be in constant touch with

the principal commercial movements in the country to which he is assigned. It is no reflection on the ability of the diplomats or consular officers. The diplomats and consular officers have their very broad range of functions, some of which are frequently connected with trade promotion. The functions of the commercial attachés as the representatives of the Department of Commerce abroad, with a nation-wide field, and the exclusive assignment to work and report on commercial legislation and practice and commercial organization, trade tendencies and currents, are quite distinct from those of the other established officers. The commercial attaché is coming, more and more, to be recognized in international dealings as distinct a position as that of the military attaché or the naval attaché.

There is another type of investigator abroad which is particularly necessary at this time. That is the trade commissioner or commercial agent—it makes no difference what you call him—who shall have the assignment to give us news about the national resources and the trade opportunities of the countries that we know very little about. There are still several countries that come within this class. I can mention Colombia and Venezuela, the Dutch East Indies, Egypt, South Africa, and New Zealand as examples. While we have had consuls located in important trade centers in these countries, the work of the consuls and consuls general is so burdensome, so multifarious, and, at times, so entirely local, that it has not been possible for us to get anything like adequate trade information from them with regard to the countries as entities. What we now need in a great many foreign countries is a trade commissioner—we may call him a resident trade commissioner—who will travel from place to place in the countries, reporting on the resources, nature of present and potential trade relations, land and water transportation, and the other things that American business men need to know in order successfully to do business with those countries. Even in some of the countries where we have a commercial attaché it now seems advisable also to have a trade commissioner who can go about from place to place—many times to places where no American representative ever has been—to make known the facts for the benefit of our trade and industries, and, of course, always in the development of the trade and economic life of the foreign countries. We have in the past had such surveys made of some of the Central American countries. We had one made of Cuba several years ago. I have had business men tell me that these are the types of trade studies that help them, and that we ought to have such trade studies made for all foreign countries. These trade commissioners with country assignments would operate without any staff, would, of course, not attempt to keep open an office such as is a regular feature of the work of the commercial attaché, but would make personal investigations and write up their reports as they go from place to place, just as our investigators of building materials, boots and shoes, canned goods, and other industrial specialties have done for years.

Steps should be taken to give us greater latitude in the use of the commercial attaché appropriation. It is desirable to omit the provision that each attaché, regardless of the relative importance of the post, be limited to but one secretary, and that the fixed salary of the secretary be limited to \$1,500 per annum.

The staff of the commercial attaché division has to be increased to make possible the collation of all the material, both written and printed, received from the attachés. To date, the routine handling of the incoming and outgoing correspondence, involving as it does a great deal of "follow-up" work, has not permitted the fullest possible use of all data submitted. One office alope, that at Lima, during the year dispatched 2,564 communications to the Bureau, including 92 extended reports. The Far Eastern division and the Latin American division have facilities for filing and correlating material received from the attachés in which they are interested, but the lack of specialized divisions for other parts of the world throws a large part of this work on the commercial attaché division.

ACTIVITIES OF ATTACHÉS DURING THE YEAR.

BUENOS AIRES.

From the beginning of the fiscal year until the arrival of Commercial Attaché Barrett at Buenos Aires in March of this year, Lew B. Clark, secretary to the commercial attaché, was in charge of the office. Mr. Clark kept the Bureau informed regarding current commercial and economic developments in Argentina, and though the Bureau was unable to give him assistance on account of the lack of appropriations, he submitted an excellent report on the market for wearing apparel in Argentina, which has been published as one of the Miscellaneous Series. Since Commercial Attaché Barrett's arrival in Buenos Aires he has been devoting about 70 per cent of his time to war work; he is the representative in Buenos Aires for the different American war boards with commercial interests.

Buenos Aires is one of the posts at which the limitation as to the number of clerks permitted interferes greatly with the work of our service; Mr. Barrett reports that during the month of June the number of callers at his office averaged 100 daily. With only one assistant it is obvious that the regular commercial attaché work must suffer.

COPENHAGEN.

Though the commercial attaché at Copenhagen, Erwin W. Thompson, has sent much valuable information, especially relating to Germany and German activities in Scandinavia, much of his work during the year has been in connection with commercial topics of interest to the Department of State and the War Trade Board. Because of Mr. Thompson's intimate knowledge of Holland and Denmark, he was directed to proceed to London on March 1 to work with the London representatives of the War Trade Board in the matter of making commercial agreements with those countries. At the close of the fiscal year Mr. Thompson was still in London in connection with this work. While in London Mr. Thompson was also able to furnish the Food Administration with a great deal of technical information regarding food, feeds, and other rations.

THE HAGUE.

Some of the most valuable reports received from any of our commercial attachés were from Commercial Attaché Edwards. These reports dealt mainly with economic conditions in Holland and Ger-

many. From November to April Mr. Edwards worked in close co-operation with the representatives of our Government in economic negotiations relative to Holland, which were discussed during that period. At the request of the American Minister at The Hague, he made several trips to London to confer with the War Trade Board representatives. Mr. Edwards also made a trip to Paris to confer with the representatives of the War Trade Board there and with members of the American commission who were in Paris during the latter part of 1917. He spent considerable time on work connected with applications to ship goods of enemy origin lying in Rotterdam, which had been bought and paid for by American firms before the United States entered the war.

LIMA.

As the west coast of South America has been less embarrassed by the disturbance of shipping than other parts of the world, Mr. Montavon has been able to keep up the regular work of a commercial attaché perhaps more than any other of our attachés. His intimate acquaintance with Government officials and business men in his district has enabled him to be of particular assistance to American exporters, who have expressed a remarkable increased interest in the west coast of South America.

The following is illustrative of Mr. Montavon's work in promoting American trade during the year: A business house in Lima, which 18 months ago was a little front shop, has as the result of American connections made through the commercial attaché, so increased its business that it is now the best-looking and most prosperous furniture business in Lima, stocked almost exclusively with American furniture. In another case a representative of an American firm, who arrived in Lima with the intention of remaining one week, at the suggestion of the commercial attaché lengthened his stay to three weeks, and with his assistance was able to make some satisfactory connections in Lima.

Complaints of Peruvian firms against American exporters and disputes between American firms and Peruvian importers were brought to the attention of the commercial attaché at Lima, who, with the assistance of the district office managers of our district offices in the cities where the American firms were located, was able in nearly all cases to settle the disputes in a satisfactory manner, thereby not only retaining the good will of the Peruvian importer for American trade in general, but also in most cases saving actual business for American houses. In one of these cases it was possible for the American exporter, through Mr. Montavon's efforts, to avoid the payment of a fine amounting to practically as much as the salary of the commercial attaché for one year. The savings to American trade from Mr. Montavon's activities in this line alone undoubtedly amount to more than the cost of maintaining our office in Lima for the entire year. In another case it was possible to adjust the difficulties involved and by so doing to remove goods from the customhouse, making a saving of storage charges, and finally disposing of the goods without loss to the shipper.

The two most important trade reports submitted by Mr. Montavon during the year were those on the markets for wearing apparel in Bolivia and Peru, published in the Miscellaneous Series.

In addition to the regular work of a commercial attaché, Mr. Montavon has been devoting considerable time to war work, particularly with reference to enemy interests and activities on the west coast.

LONDON.

Prior to leaving London in September Commercial Attaché Williams was devoting practically all his time to commercial war work. He was meeting regularly with the interallied war committees in London in an unofficial capacity and furnishing reports which were of considerable assistance to our War Trade Board. Upon his return to the United States Mr. Williams placed at the disposal of the various departments of the Government his close experience with the administration of enemy-trading and other war-time commercial laws and practice.

Commercial Attaché Kennedy arrived in London in December and shortly after was assigned a definite share of work in conjunction with the War Trade Board. Because of his contact with American trade he was able to give valuable advice when the removal of embargoes on shipments to neutral countries was being discussed. Mr. Kennedy also submitted several important reports relating to war activities which contained information of much value to various departments of the Government, one of his reports being of sufficient importance to prompt the Food Administration to request the Bureau to obtain similar reports from all the commercial attachés. Another important report submitted by Mr. Kennedy covered British experience with the conversion of nonessential to essential industries. The office of our commercial attaché being located in the Embassy, it has been possible for Mr. Kennedy to maintain close connection with its work, and various matters of commercial and industrial importance have been acted upon by the attaché for the Ambassador. Mr. Kennedy has directly represented the War Industries Board and the War Department in negotiating orders for needed supplies.

MELBOURNE.

Up to the time of his departure from Australia, in September, Mr. Kennedy continued the work of an educative character mentioned in the last annual report. Our entrance into the war had eliminated much of the unfavorable opinion in Australia, but there was still room to promote commercial understanding. With this in view Mr. Kennedy delivered a number of addresses before prominent private, as well as official, bodies. One of his addresses to the Bankers' Institute of Australasia in Melbourne was published in full in the magazine of the Bankers' Institute and also appeared in the leading Australian financial journal.

During his stay in the United States, from September to November, Mr. Kennedy visited the principal commercial centers of the United States, appearing before chambers of commerce and foreign-trade organizations in various cities and interviewing business men on the subject of our trade with Australia and New Zealand. He submitted reports on the wheat-storage situation in Australia. This material was transmitted to the Food Administration, and when Mr. Kennedy was in Washington he conferred with Food Administration

officials regarding Australian wheat and other food commodities of which there was a surplus in Australia. He was also able to obtain considerable confidential information regarding the wool situation and shipping conditions in Australia, which was transmitted to interested departments of the Government. Since his departure from Australia our office has been in charge of Howard A. Treat, secretary to the commercial attaché, who has kept us informed regarding commercial and industrial developments there.

PARIS.

Like our other commercial attachés, Dr. Veditz, at Paris, was able to render valuable assistance to the Government in its war activities. He assisted the officers in command of our forces in France in studying conditions at French ports prior to the arrival of our first contingents. He also aided the Quartermaster Corps of our Army in the purchase of supplies locally. At the request of the Ambassador, Dr. Veditz attended, unofficially, the conferences of the allied representatives in Paris on commercial subjects.

Dr. Veditz left France in March, and was succeeded by P. C. Williams, who was then in Paris accompanying the chief representative of the War Trade Board. Since his appointment Mr. Williams has naturally given the bulk of his time to war-trade matters, although, with his years of foreign-selling experience, he does not neglect the forward-looking viewpoint in his reports and negotiations.

PEKING.

Since January Commercial Attaché Arnold has been acting as chairman of the International Customs Conference, which is meeting in Shanghai for the purpose of discussing the Chinese tariff, in this capacity representing the United States on this important body. During his absence from Peking our office there has been in charge of Commercial Attaché A. W. Ferrin, who was appointed to the Melbourne post upon the transfer of Mr. Kennedy to London, but who, on account of the absence of Mr. Arnold, has remained in Peking, from which point he has been able to keep the Bureau informed regarding important financial and commercial developments in China. Mr. Arnold has continued his educative work. At his suggestion, the director of the China Union School of Languages has accorded facilities for the study of the Chinese language to American business men, American women, and United States marines stationed in China. This will no doubt contribute to our commercial effectiveness in China.

Mr. Arnold has also been conducting a motion-picture campaign for the purpose of familiarizing the Chinese with American commercial and industrial conditions and American trade methods; he has exhibited throughout China, in important commercial centers, pictures showing the work of American industrial and trade organizations. For this purpose the Bureau purchased and shipped to Mr. Arnold a motion-picture projecting machine. Several films depicting the work of American business firms and manufactories have been secured by the Bureau and forwarded to him for exhibition.

Mr. Arnold made a trip to South China during the year to learn the needs of our trade in that part of the country. He has also been

working on a handbook on China. This important book will be completed in the fiscal year 1919 and will be published at a most propitious time. Under Mr. Arnold's direction, a commercial map of China has been prepared for the American Chamber of Commerce in China; the map, of which copies have been furnished the Bureau, has attracted considerable attention in the United States, and several requests have already been received for copies for private firms as well as for Government departments. Though Mr. Arnold has been engaged in work on the International Maritime Customs Conference and in conducting the campaign of the American Red Cross, he has been able to assist American firms in extending their business in China, the Bureau having received several commendatory letters from American firms regarding his work. In an article on trade in China in the Foreign Trade Supplement of the London Times, Mr. Arnold's work was highly commended, the writer of the article referring to Mr. Arnold as "the best-trained man in China, for his job."

PETROGRAD.

In a year of confusion and excitement the work of our commercial attaché at Petrograd, like that of the other American officials in Russia, extended to all sorts of activities of general helpfulness to Americans and American interests in Russia. Working directly under the Ambassador, he represented our commercial interests as instructed from the Department and as immediate circumstances made advisable. Most new business became impossible, but old business brought plenty of complications, which had to be straightened out as well as possible.

RIO DE JANEIRO.

Commercial Attaché Downs left Rio de Janeiro for the United States during the month of August, and upon his arrival visited the principal commercial and industrial centers of the United States, meeting various chambers of commerce, foreign-trade organizations, and business men interested in our trade with Brazil, whom he informed regarding trade conditions. He gave important information to various departments of the Government in Washington regarding supplies needed in the war activities of the United States. Prior to his departure from Rio de Janeiro he completed his report on the market for wearing apparel in Brazil. At the expiration of his leave of absence Mr. Downs resigned from the service. I want to go on record as asserting that few men of Mr. Downs's long and responsible experience in foreign trade would have made the financial sacrifice or could have made as valuable a contribution to national trade promotion as he has made in the years he stayed in the service. Unfortunately, Mr. Antonio Gomez, secretary to the commercial attaché, also resigned, and on account of the difficulty in securing a suitable man to succeed Mr. Downs the office in Rio de Janeiro was closed temporarily.

Shortly after the beginning of the new fiscal year the vacancy was filled by the appointment of J. E. Philippi as commercial attaché and Richard M. Connell as clerk. Mr. Philippi is another American commercial attaché who brings to his work not only strength of personality but also long personal experience in Latin American trade.

TOKYO.

Our office in Tokyo was established upon the arrival of Commercial Attaché Rutter in Tokyo on July 26. A temporary office was opened in the Embassy the following day and the commercial attaché at once became of service in acquainting business men in Japan with the reasons which impelled our Government to conserve needed supplies for war purposes. The first list of restricted imports having just been proclaimed by the President, and the commercial attaché having so recently come from the United States, he was in a position to explain satisfactorily certain regulations of our Government which were resented in Japan. Most of the thought and effort of the commercial attaché has naturally been devoted to war problems. The installation of a new office has also necessitated some work of a routine character and establishment of points of contact with business men and Government officials. Several trips were made for the purpose of studying industrial methods. There has been constant collaboration with the resident diplomatic and consular officers of our Government. The commercial attaché has conducted his office as part of the Embassy and has constantly represented the American business man's point of view as reflected through the Department of Commerce as he has exchanged information with other members of the staff.

TRADE COMMISSIONERS.*

The object of the special agents' service of the Bureau is the extension of foreign markets for American manufactures. The primary function of these special agents is the thorough investigation of conditions which American manufacturers must meet in foreign markets rather than the direct promotion of the sale of American goods, although they have incidentally been of great assistance in the latter respect. The results of the Bureau's foreign-market investigations have met with wide appreciation on the part of American manufacturers and exporters, as the information obtained by the special agents could in most instances be made available to our business public by no other means.

The work of the special agents is distinct from that of the commercial attachés of this Department and the consuls and diplomatic officers of the Department of State. Special agents are chosen with a view to their particular knowledge of the line to be investigated and their general appreciation of commercial and economic conditions both in this country and abroad. Their specialized work is retarded by no collateral duties, their sole function being to analyze exhaustively and present concisely the competition which American manufacturers must meet in order to extend their foreign sales.

The candidates for these investigations are selected as a result of competitive examinations designed to test a man's technical knowledge of the industry in question, his familiarity with the languages of the countries to be investigated, his general grasp of trade conditions, and his ability to write clear and concise reports. Thus, for an investigation of agricultural implement markets abroad a trained implement man is engaged. Before he goes abroad he talks with the manufacturers of implements. He shapes his reports to tell them

* Henceforth the foreign investigators, as a rule, will be known as trade commissioners, and the designations commercial agent and special agent will not be used.

the things they want to know. When he comes back he visits as many of the manufacturers as possible to answer questions with reference to particular points that may not be covered in detail in the reports. The agent must command the respect of the manufacturers and he must command the respect of the dealers abroad. He must know his line, must be a good traveler, a good report writer, a good talker—and into the bargain the chances are that he must know at least one foreign language.

After their return to the United States upon the completion of their foreign work, the Department attaches much importance to having special agents revisit the important trade centers and personally acquaint interested manufacturers with the results of their investigations. These personal interviews effectively supplement the voluminous reports published by the Bureau, as the special difficulties of individual manufacturers can often be better discussed in this manner. The results of the special agent's investigations are, therefore, brought to the attention of the business public in three ways: (1) By personal interviews before and after his investigation; (2) by correspondence during his foreign travels, as special circumstances of interest to particular manufacturers arise, or after his return; and (3) through the medium of his published reports.

The cooperation of the various chambers of commerce, trade associations, and other organizations interested in foreign trade, and of the various manufacturers, has greatly assisted the Bureau in this work. Suggestions as to new investigations, changes in the manner of conducting the work, the scope of particular investigations, etc., are welcomed from any source. The constant aim of the Bureau is to make the special agents' work of the utmost practical value to those interested in foreign trade.

During the last year the work of nearly all the special agents has proved of distinct value in connection with the Government's war activities. Shortly after the declaration of war by the United States, the various agents abroad were instructed to give attention to special features of interest in connection with the Government's war program in addition to their regular work of investigating foreign markets. A detailed summary of such assistance rendered by the special agents is given on another page, but it may be mentioned here that specially valuable work was done in connection with the trading-with-the-enemy restrictions by reporting the status of foreign concerns and in connection with foreign sources of minerals and other materials essential to our war industries.

In the late autumn and early winter a number of the special agents returned from the Far East and from Latin America. Their first-hand information concerning commodities serving war needs and market conditions in these countries was immediately placed at the disposal of the various war bodies. The investigations now in progress, as well as those to be undertaken during the fiscal year 1919, will necessarily continue to contribute in increasing measure to the effectiveness of the Government's war activities in connection with the stimulation of our war industries, the elimination of enemy interests, and the preparation for the economic readjustments of the after-war period.

TRADE INVESTIGATIONS.

There are at the present time 18 investigations in progress and 9 in immediate contemplation. The following table indicates all the investigations which had not been completed at the beginning of the last fiscal year. Those marked with an asterisk are now completed, although in a few instances final reports have not yet been issued.

INVESTIGATIONS OF FOREIGN MARKETS MADE BY TRADE COMMISSIONERS AND SPECIAL AGENTS OF THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE, YEAR ENDED JUNE '30, 1918.

SPECIFIC TRADE INVESTIGATIONS.

Subject of investigation.	Agent.	Country.
*Agricultural implements and machinery.....	Homs.....	Australasia and South Africa.
*Boots and shoes, leather, and shoe findings.....	Bosworth.....	Far East.
Do.....	Brock.....	Latin America.
Construction materials and machinery.....	Ewing.....	Do.
*Cotton goods.....	Odell.....	Far East.
*Electrical goods.....	Lundquist.....	Far East and Australasia.
Do.....	Smith.....	Latin America.
Furniture.....	Everley.....	Do.
*Hardware.....	Williams.....	South Africa.
Jewelry and silverware.....	Rosenthal.....	Latin America.
Lumber markets.....	Brown.....	Spain, Portugal, Italy, and Greece.
Do.....	Walker.....	England, France, Switzerland, and Holland.
Lumber production and export methods.....	Oxholm.....	Scandinavia and Finland.
Do.....	Simmons.....	Russia and Siberia.
*Motor vehicles.....	Tom O. Jones.....	Far East.
*Paper, paper products, and printing supplies.....	Barrett.....	Latin America.
Railway material, equipment, and supplies.....	Rhea.....	Far East and Australasia.
*Textiles.....	Tucker.....	Latin America.

GENERAL INVESTIGATIONS.

Advertising methods.....	Sanger.....	Latin America.
Chemical imports into the United States.....	Pickrell.....	All foreign countries.
Commercial and economic conditions.....	Anderson.....	Scandinavia.
*Danish West Indies (general conditions).....	Smith, Brock, and Tucker.....	Virgin Islands.
Export merchandising methods.....	Cherington.....	United States.
*India rubber production.....	Pearson.....	All rubber-producing countries.
*Investment opportunities.....	Halsey.....	Latin America.
Do.....	Ferrin.....	Far East.
Mineral resources.....	Clements.....	Do.
Ports, transportation facilities, and packing.....	G. M. Jones.....	Latin America.
Ports and transportation facilities.....	Whitham.....	Far East.
*Tanning materials.....	Norton.....	Latin America.
Tropical agricultural products.....	Strachan.....	Central America.

INVESTIGATIONS COMPLETED DURING THE YEAR.

AGRICULTURAL IMPLEMENTS.

The investigation of the markets for agricultural implements in Australia, New Zealand, and the Union of South Africa was completed by Special Agent Juan Homs in December, 1917. All these countries are logical fields for American trade extension, particularly in lines where Great Britain is not an important competitor. In New Zealand and South Africa, where the policy of encouraging local manufactures is not so well established, prospects for increased American exports are particularly good. During the year the following monographs by Mr. Homs were published: Special Agents Series No. 146, "Markets for Agricultural Implements and Machinery in South Africa," and No. 166, "Agricultural Implements and Machinery in Australia and New Zealand."

COTTON GOODS.

Ralph M. Odell completed the work in connection with his study of cotton-goods markets in British India and Ceylon during the first part of the fiscal year. The results of Mr. Odell's work in establishing relations between foreign importers and American manufacturers and in making known in the East the quality of American goods have been highly appreciated by the trade. The following monographs were published during the year: Special Agents Series No. 149, "Cotton Goods in British India; Part IV, Bombay Presidency"; and No. 157, "Cotton Goods in British India," containing Part V, Summary of Trade, and Part VI, Cotton Manufacturing.

ELECTRICAL GOODS.

R. A. Lundquist has completed his investigation of markets for electrical goods in Australia, New Zealand, China, Chosen, and Japan. The elimination of German competition in all these countries has naturally resulted in stimulating imports of American goods, and Mr. Lundquist has pointed out in his reports and by personal interviews with manufacturers the means by which this trade may be retained and extended. Of particular interest is the remarkable development of the Japanese electrical industries during the last four years. Japanese competition with American electrical goods, however, will probably be limited to the cheaper lines. During the year the following monographs by Mr. Lundquist were published: Special Agents Series No. 147, "Electrical Goods in New Zealand," and No. 155, "Electrical Goods in Australia."

The investigation of markets for electrical goods in South America, conducted by Special Agent Philip S. Smith, is nearing completion. The influence of the German electrical industry on South American demands has been very great, owing partly to the fact that in many cases specifications for electrical installations are based on German practice. The supplies of German goods have long been exhausted, however, and it has been very difficult to obtain any samples whatever of such articles. With the restricted imports of other foreign electrical goods and the almost complete lack of local manufactures, the United States manufacturers have had an unusual opportunity to establish themselves in the market. The following monographs by Mr. Smith appeared during the year: Special Agents Series No. 154, "Markets for Electrical Goods in Ecuador and Peru," and No. 167, "Electrical Goods in Bolivia and Chile."

HARDWARE.

The investigation of the possibilities of South Africa and Portuguese East Africa as a market for American hardware disclosed an eagerness on the part of importers to enter into permanent trade relations with this country. With the establishment of direct steamship communication and the increasing export of wool, leather raw stock, and other raw materials from South Africa to the United States, there is little doubt that American builders' hardware, plumbers' goods, small hardware, and mining supplies, as well as other articles formerly supplied in large measure by European countries,

will find a ready market in South Africa. The report of Charles S. Williams, who conducted this investigation for the Bureau, will be published in the near future.

MOTOR VEHICLES.

Owing to changed conditions resulting from the war, the investigation by Tom. O. Jones was limited to markets for motor vehicles in Japan, China, and Hawaii. While both China and Japan are at present small markets from an American standpoint, there are certain methods available to our exporters of motor vehicles which would enable them to increase materially their present sales and lay the foundation for a profitable future trade. The demand in the Far East will undoubtedly greatly increase as the result of the rapid industrial development of some of these countries and their consequent interest in road improvement and extension. The following monograph by Mr. Jones was published during the year: Special Agents Series No. 170, "Markets for Motor Vehicles in China, Japan, and Hawaii."

PAPER, PAPER PRODUCTS, AND PRINTING MACHINERY.

The investigation of the market for these products in South America and Cuba was completed in January, 1918, by Robert S. Barrett. Besides describing in detail the demand for all kinds of paper and publishers' supplies in South America, a field which has been largely dominated by German products, Mr. Barrett made a very comprehensive survey of the entire newspaper situation in Latin America. This information was particularly valuable in connection with the Government's efforts to deal with anti-American and pro-German propaganda in those countries. While high-price level and other abnormal factors make it difficult for the United States at present to increase its gains in the South American paper-products trade it is expected that the results of this investigation will be shown in the after-war statistics of paper exports to South America. During the year the following monographs prepared by Mr. Barrett were published: Special Agents Series No. 153, "Chilean Market for Paper, Paper Products, and Printing Machinery"; No. 163, "Paper, Paper Products, and Printing Machinery in Argentina, Uruguay, and Paraguay"; No. 171, "Brazilian Markets for Paper and Paper Products, Including Machinery."

SHOES AND LEATHER.

The well-known popularity of American shoes in foreign countries where they have been properly advertised led the Bureau to undertake a study of possible markets in Latin America, Australasia, and the Far East. The investigation of Clarence E. Bosworth, covering Australasia, the Philippines, China, and Japan, was completed during the winter. The results of his work in Australasia were very promising, and in China and Japan, particularly in the latter country, the growing tendency toward occidental customs should be to the advantage of American shoe manufacturers, provided proper selling arrangements are made. The installation of American shoe

machinery in a number of the countries covered by these investigations is resulting in a marked decrease in imports of boots and shoes. On the other hand, the demand for American leather, particularly high-grade upper leather, is everywhere on the increase. The following monographs by Mr. Bosworth were published during the year: Special Agents Series No. 151, "Shoe and Leather Trade in New Zealand"; No. 159, "Shoe and Leather Trade in Australia"; and No. 161, "Shoe and Leather Trade in the Philippines."

Herman G. Brock completed his investigation of Latin American markets for shoes, leather, and shoe findings during the winter. The stimulation of local manufactures due to war conditions has been particularly marked in the case of the boot and shoe industry in the more advanced South American countries, such as Argentina, Brazil, and Chile. A tendency toward even higher custom duties is also partly responsible for the curtailment of imports of foreign footwear. In the smaller markets of Latin America, however, conditions are favorable for extending American sales of shoes, while the market for American shoe findings and upper leather of all kinds is everywhere most promising. The following monograph by Mr. Brock appeared during the year: Special Agents Series No. 152, "Markets for Boots and Shoes in Peru."

TEXTILES.

The investigation of Latin American markets for textiles conducted by W. A. Tucker was not completed, owing to Mr. Tucker's resignation from the service after completing his work in Chile. This investigation will in all probability be continued during the coming fiscal year, however, in view of the great importance of the River Plate countries, Brazil, Colombia, and Venezuela as future markets for American cotton goods and other textile products. Mr. Tucker's work in the west-coast countries of South America brought out very strikingly the fact that American textile manufacturers should, if possible, select American or Latin American houses as local representatives. The natural tendency of the import houses of European nationality is to push the sale of their national products to the detriment of American goods. Foreign markets for textile products depend to such an extent upon a correct understanding of the foreign consumer's preferences as to patterns, dimensions, quality, etc., that the detailed study of these factors by the special agents of the Bureau is believed to be almost essential to the general success of the United States export trade in this line. The following monographs by Mr. Tucker appeared during the year: Special Agents Series No. 158, "Textile Markets of Bolivia, Ecuador, and Peru"; No. 164, "Textile Markets of Chile"; and No. 168, "Wearing Apparel in Chile."

RUBBER PRODUCTION THROUGHOUT THE WORLD.

In view of the increasing importance of manufactured rubber in modern industry and the dependence of the United States on foreign sources of raw materials, the Bureau arranged with H. C. Pearson, editor of the *India Rubber World* and a well-known authority on rubber production and manufacture, for a study of sources of raw rubber, export methods, and other factors affecting the domestic rub-

ber industry. One of the most interesting features of Mr. Pearson's work is his study of experiments with guayule cultivation in the desert lands of our Southwestern States. These experiments have now reached the stage where it may be predicted that within a comparatively short time guayule production within our own borders will be commercially profitable. The conditions prevailing in the rubber-producing regions of Brazil, the East Indies, and other parts of the world are fully covered in Mr. Pearson's monograph, which will be published in the near future.

PORTS, TRANSPORTATION FACILITIES, AND EXPORT PACKING.

G. M. Jones, who conducted this investigation in South America, was recalled before the completion of his field work in order to assume new duties as Assistant Chief of Bureau, which have delayed the preparation of his reports. The most persistent criticisms of American packing and shipping arrangements have probably come from the west-coast countries of South America, where transportation facilities are on the whole more primitive than in most other parts of the world. The results of Mr. Jones's investigation in these west-coast countries will be published as soon as possible. It is gratifying to be able to state that the packing of American goods has greatly improved during the last few years, although of course some American concerns, usually those unfamiliar with the requirements of the export trade, have been negligent in this regard. There is no doubt, however, that the shortcomings of American packing and export methods in general have been greatly exaggerated by our foreign competitors.

INVESTMENT OPPORTUNITIES.

F. M. Halsey's study of investment opportunities in Latin America was completed during the spring. While the demands of the war will prevent the diversion of American capital to foreign countries for the present, the attractiveness of South America as a field for American investments will doubtless be more generally recognized after the war. As is well known, the very large investments of Great Britain in South America have been partly responsible for the long ascendancy of British manufacturers in those markets. From the standpoint of United States foreign trade, and in order to promote further the existing good relations with the South American Republics, it will be well for our investing public to give more attention to South American opportunities during the after-war period. Mr. Halsey's thorough survey of the more important investment possibilities in Latin America will be of great assistance at that time.

INVESTIGATIONS NOW IN PROGRESS.

CONSTRUCTION MATERIALS AND MACHINERY.

The investigation of markets in Cuba, Argentina, and the west-coast countries of South America has been completed. The work of W. W. Ewing, the engineer undertaking this investigation, has already attracted favorable notice, and it is expected that the publication of his reports on Chile, Argentina, and Brazil, the most promising markets for such articles in South America, will materially

assist the trade in the United States. The high prices obtained in Peru and Chile for raw materials needed in the war industries of the belligerent countries have resulted in unusual prosperity, which will probably be reflected in renewed building activities upon the conclusion of the war. The export embargoes of the United States and other belligerent countries and the present abnormal prices and lack of tonnage have resulted in greatly curtailing recent imports of construction materials and machinery in all South American countries. The end of the war will consequently be apt to bring about an unusually large demand in Argentina, Brazil, and other countries covered by Mr. Ewing, for these essential supplies. The following monograph by Mr. Ewing was published during the year: Special Agents Series No. 160, "Market for Construction Materials and Machinery in Colombia."

FURNITURE.

The investigation of Special Agent Harold E. Everley covering the South American markets for American furniture has disclosed a remarkable development of the local industries. Particularly successful, apparently, have been the attempts to increase the local production of the cheaper grades of household furniture. With the restoration of normal conditions it is probable, however, that many American lines will be sold as heretofore on a quality basis. American manufacturers are urged to ship their furniture knock-down in order that the price level may be kept nearer the figures prevailing in the domestic market. The following monograph by Mr. Everley was published during the year: Special Agents Series No. 162, "Colombian Markets for American Furniture."

JEWELRY AND SILVERWARE.

Special Agent Samuel W. Rosenthal has recently completed his study of jewelry and silverware markets in Cuba and the west-coast countries of South America. Mr. Rosenthal's work has shown very graphically the influence of foreign houses in South America on local preferences. The long-established German and French concerns, which naturally prefer to feature the products of their respective countries, make it difficult to popularize American styles. Much progress has been made, however, by our manufacturers during the past two years. It should be mentioned that Mr. Rosenthal has been able to acquaint foreign buyers with the merits of our jewelry in localities where the American goods were practically unknown.

LUMBER.

J. R. Walker has completed his preliminary work in Great Britain and France in connection with after-war markets for American lumber. He has done very effective publicity work in England in convincing British officials and importers that American construction woods are stronger in proportion to size than the softer woods of the Baltic countries. The impression has hitherto prevailed in England and elsewhere in Europe that the smaller sizes of American timber would not represent the same degree of strength as the somewhat larger dimensions of the Baltic woods. Hardwood mar-

kets have also been given special attention by both Mr. Walker and Mr. Brown.

Nelson C. Brown has completed his preliminary study of after-war lumber markets in the Spanish peninsula and Italy. His work will also include a survey of the demand for American lumber in the North African countries and in Greece. The devastation of war in France and Italy and the impossibility of securing normal lumber supplies in the other countries, due to embargo regulations and lack of tonnage, will make all these countries very important markets for American woods in the after-war period.

A. H. Oxholm has completed his study of timber resources and export methods prevailing in Finland in spite of very adverse conditions, and has also finished his preliminary survey of the Swedish lumber industry. The highly efficient export methods of the Swedish lumber concerns will undoubtedly be of great interest to the American lumber trade. Mr. Oxholm's work in Norway, Sweden, and Finland will also indicate to our lumber exporters the probable extent of the after-war competition in these important lumber-producing countries, as well as the best means of meeting it.

Roger E. Simmons has pursued his study of Russian timber resources in the face of many difficulties. His investigation of the inaccessible forest regions of eastern Siberia was genuine pioneer work, as it is believed that no reliable information concerning the timber resources of this important potential source of supply is available. Mr. Simmons, at great personal inconvenience and risk, continued his work in European Russia. In view of the enormous forest resources of Russia and the recent revival of German economic penetration, his analysis of the factors that will influence after-war output should be of unusual value to American producers.

RAILWAY EQUIPMENT, MATERIAL, AND SUPPLIES.

Mr. Rhea's investigation of markets for railway equipment in Australasia, China, and Japan was completed during the winter, and his voluminous report on conditions in Japan, China, and Chosen will shortly be issued. While primarily a survey of the opportunities for extending the sale of American railway appliances abroad, Mr. Rhea's work in the Far East has been particularly timely and valuable from other points of view. For instance, the high efficiency of the Government-controlled railways of Japan is very instructive in connection with recent developments in this country. The intricate system of railway and other public-utilities concessions in China was necessarily studied in some detail in connection with Mr. Rhea's investigation of possible markets for American manufactures. The general railway situation in China and the general financial and economic conditions in that country are of particular interest at present, in view of the renewed interest in the subject of Chinese loans and the possibility of China's greater participation in the war. The following monograph by Mr. Rhea was published during the year: Special Agents Series No. 156, "Markets for Railway Materials, Equipment, and Supplies in Australia and New Zealand."

INVESTMENT OPPORTUNITIES.

A. W. Ferrin continues his study of financial and economic conditions in China. A thorough study of China's finances, banking

facilities, concessions of various kinds, and industrial possibilities will be particularly timely in view of current political developments. Mr. Ferrin's work in connection with investment opportunities has been considerably delayed by reason of his acting as commercial attaché at Peking during the absence in South China of Commercial Attaché Julean Arnold.

MINERAL RESOURCES.

J. Morgan Clements has completed his survey of the mineral resources of Japan and his comprehensive report is practically completed. In view of the great importance of the metallurgical industries and the availability of raw materials for their development in an industrially new country, Mr. Clements's work should prove of permanent value to students of Japanese commercial and economic life. Mr. Clements is about to return to China, where he will make an investigation of the mineral resources, which are destined to play so important a part in its future development. China's mineral resources as a basis for her economic and commercial development, as an investment field for American capital, and as a necessary addition to the stock of raw materials required by our war industries, are among the principal features of Mr. Clements's forthcoming investigation.

PORTS AND TRANSPORTATION FACILITIES.

The study of ports, harbors, and interior transportation facilities of all kinds in China and the Far East is being continued by Paul P. Whitham. The tremendous potentialities of China as a market for American products and a field for American enterprise seemed to make such an investigation very desirable. The importance of China from the point of view of international politics and the generally expressed desire of representative Chinese for the increased participation of the United States in Chinese industrial development should also make Mr. Whitham's work of unusual value.

ADVERTISING METHODS.

The growing interest in Latin America as a market for an increasing volume of American exports and the lack of information on the part of the American advertising agencies regarding Latin American methods resulted in the undertaking of such an investigation by J. W. Sanger. Mr. Sanger has completed his observation of conditions in Cuba and west-coast countries of South America, but his report on these countries will probably not be published until his return to the United States after completing his study of conditions in Argentina and Brazil. Differences in psychology, social customs, racial traditions, and other features make it very important for American exporters to realize that a sales appeal admirably adapted to American needs may be ineffective in a Latin American country.

EXPORT MARKETING METHODS.

The research work on this subject undertaken by Prof. Paul P. Cherington was not completed, owing to his assignment to important war work by the United States Shipping Board. The great success

of many houses in building up a profitable export trade and the comparative failure of other concerns apparently well qualified to succeed in export trade make it highly desirable for the Bureau to complete a careful analysis of the various export methods employed. Such a survey would naturally be an unprejudiced attempt to set forth the relative value of certain methods of merchandising as applied to different classes of firms, foreign markets, etc. This work will be resumed and completed as soon as opportunity offers.

COMMERCIAL AND ECONOMIC CONDITIONS IN SCANDINAVIA.

Norman L. Anderson was sent to Christiania in January, 1918, to study economic and commercial conditions in the three Scandinavian countries. The unusual prosperity of these countries during the first part of the war caused a wider demand for various manufactures which after the war might be supplied by the United States. More recently the severe blockade restrictions have resulted in the development and extension of new industries in all these countries. Of even greater importance than his reports concerning developments in Scandinavia, however, is the valuable information concerning current tendencies in Germany and in Russia which Mr. Anderson has been able to obtain while in Copenhagen and in Christiania,

PRODUCTION AND EXPORT OF TROPICAL PRODUCTS.

At the request of the United States Shipping Board, the Bureau detailed W. A. Strachan, formerly a district office commercial agent, to investigate the production and export of certain tropical products in Central America and Colombia. The stimulation of production and improvement of export facilities for certain of these products is of great importance in connection with the Government's war program. Mr. Strachan is also obtaining for the Bureau valuable information regarding general commercial conditions in the Central American countries.

PLANS FOR THE FISCAL YEAR 1919.

During the fiscal year 1919 the Bureau intends to conduct a number of general investigations in countries regarding which American exporters have very limited information, as well as at least two new studies of markets for particular commodities.

The proximity of Colombia and Venezuela and the importance of the United States as a purchaser of their raw materials make these two countries logical markets for American manufactured goods. It is believed that with proper efforts there might be a considerable extension of export trade to these countries, and it is planned to assign a special agent to them for the purpose of making general trade investigations and compiling a handbook, which will be of great assistance to exporters interested in this field.

The importance of Bolivia and Paraguay as a source of raw materials needed in American industries and as a field for increased sales of a limited number of American products should be recognized. It is the intention to assign another special agent to these two countries

during the coming fiscal year. These rather inaccessible countries are probably the least known of all the Latin American Republics and a commercial handbook outlining in detail their present needs and economic possibilities has long been needed.

There has recently been a considerable revival of interest in Mexico as an export field, particularly since the curtailment of over-sea shipping facilities. As Mexico was, prior to the revolution, a highly important market for United States products, it is felt that a study of present commercial conditions should no longer be delayed. A third special agent will accordingly be detailed to Mexico during the coming year, according to present plans.

In view of the interest of the paint and varnish manufacturers in extending their export trade, the Bureau hopes to conduct an investigation of Latin American markets for these products. Some of the less developed countries where the possible market would at best be very limited will probably be omitted in this survey, in order that the special agent undertaking it may concentrate to better advantage on the important markets, which include Argentina, Brazil, Chile, and Cuba.

The highly important investigation of Latin American textile markets started by W. A. Tucker will be resumed as soon as a suitable candidate for this position can be found.

Because of the small purchasing power of the masses of the population and the very limited demand for most manufactured goods in the Far Eastern countries, it is felt that the funds available for trade extension there can be most advantageously applied at this time to basic investigations rather than to studies of markets for particular manufactured commodities. The work of Messrs. Whitham and Clements, who are investigating, respectively, transportation problems and mineral resources in the Far East, will therefore be continued during the coming year. It is also planned to detail a special agent to some important distributing center of the Far East such as Batavia, Singapore, or Manila to undertake general trade-promotion work. Another special agent will probably be detailed to Shanghai to supplement the efforts of Commercial Attaché Julian Arnold in Peking.

There are a number of new investigations in the Far East which would be well worth while if funds were available. As it is possible to undertake but one new special investigation, however, it has been practically decided to assign a mechanical engineer with commercial experience to the investigation of markets for certain classes of industrial machinery. The remarkable expansion of industry in Japan and, to a less degree, in China and British India during the last four years makes such a survey particularly timely. This investigation will necessarily involve a study of basic conditions and tendencies in the economic life of the Far East which will be valuable in connection with future American trade extension in various lines.

The Union of South Africa as a future important market for American products has been somewhat neglected in the past, but the closer commercial relations between that country and the United States brought about by war conditions and other factors make it a promising field for American manufacturers. R. A. Lundquist, who has just completed for the Bureau an investigation of markets for electrical goods in Australasia and the Far East, will accordingly

be detailed to South Africa for an indefinite period to engage in general investigation and trade-promotion work.

South African purchases of American manufactures have steadily increased for some years, although the gain has been much greater since the outbreak of the war. South Africa is essentially an importing country so far as manufactured goods are concerned, and this, together with the fact that the tariff preference in favor of British products is smaller there than in any other British self-governing dominion, should result in the further increase of imports from the United States. Direct steamship connection with this country and greatly increased imports into the United States of South African leather raw stock and wool are important factors in the closer commercial relations now prevailing. Mr. Lundquist will also cover Portuguese East Africa, which in itself is a considerable market for certain products important in United States export trade.

It is apparent that it would be inopportune to undertake special investigations of markets for American manufactures in European countries until the end of the war is plainly approaching. For this reason no immediate plans are announced for special work during the coming fiscal year, although such studies can be undertaken upon very short notice should a sudden change in the military situation indicate the early end of hostilities.

The field for European investigations immediately upon the conclusion of the war will be so extensive that the Bureau will probably be unable, because of insufficient funds, to undertake some investigations which should undoubtedly be made. The following are among the market investigations which should be undertaken in Europe at that time: Industrial machinery of various kinds; mill and factory equipment other than machinery; builders' and other hardware; construction materials other than lumber; machine tools; railway equipment and supplies; electrical equipment for industrial plants and small electrical goods; motor vehicles, tires, and other accessories; agricultural machinery and implements of all kinds; kitchen utensils and sanitary supplies and appliances. These are among the investigations which should be started immediately after the war ends. The demand for less essential articles should also be considered as funds become available.

It should be remembered that, apart from the direct devastations of war in Belgium, France, Russia, Italy, and elsewhere, normal industrial life has everywhere been seriously affected. The manufacture of many less essential articles has been discontinued or greatly curtailed in all European countries. Furthermore, the import restrictions enforced in nearly all the belligerent countries have resulted in a great shortage of many articles formerly imported in large quantities from the United States. The need for a systematic survey of after-war requirements of nearly all European countries in many lines is, therefore, quite apparent. It is particularly important that the Bureau be in a position to revive certain necessary investigations planned for Russia and abandoned for obvious reasons. The Russian market is clearly of vital importance from the standpoint of international politics. It is essential that American manufacturers be given prompt and thorough assistance in their efforts to combat German economic penetration there upon the coming of peace.

The effect of the war upon the industrial life of Germany and, to a less extent, upon the economic life of the other belligerent countries is a matter of very practical significance to American manufacturers and exporters. It is of more than academic interest to follow current developments and tendencies in the industrial nations of Europe which will be our principal competitors in the after-war period.

The research work already performed by Special Agent Norman L. Anderson, who has been assigned to the Scandinavian countries for the last six months, has demonstrated the value of having properly qualified trade observers in certain commercial centers of Europe. In anticipation of the commercial and economic readjustments of the immediate after-war period, similar commercial intelligence agents should be detailed to other neutral and to some of the belligerent countries.

The opportunities for interpreting current tendencies in Germany and Austria-Hungary are best in Switzerland, Holland, and Denmark, while Sweden and Denmark are favorable fields for obtaining similar information concerning Russia and Finland. For this reason it is hoped that the Bureau's limited funds will permit the collection of such data from special agents detailed to these countries before the conclusion of the war.

WAR WORK OF SPECIAL AGENTS.

Since the declaration of war by the United States, the division of commercial agents has given assistance to various war bodies of the Government. The services of the special agents in this connection are of three kinds. Most important probably is the first-hand information given in personal interviews with officials of the War Trade Board, War Industries Board, Council of National Defense, War Department, Navy Department, Department of State, Shipping Board, and Railway Administration after their return from their foreign investigations. Another valuable contribution of the special agents is the special reports which they transmit to the Bureau while still abroad. These reports have been of great value on such subjects as flagrant instances of enemy propaganda abroad, current conditions in Germany, Russia, and Finland, usually based on interviews with persons returning from those countries, foreign sources of important raw materials, etc. Lastly, many of the special agents, because of their intensive study of the particular line covered by these investigations, are able to supply consular and diplomatic officers and War Trade Board officials in foreign countries with valuable information during the progress of their work abroad.

The following are among the instances of material assistance rendered by the special agents in connection with the war work of the Government:

The data supplied by Norman L. Anderson regarding current economic developments in Germany and the effect of the war and the blockade on conditions in Scandinavia has proved of value to the War Trade Board, the War Department, and other Government agencies interested in the rationing of neutrals and the economic attrition of Germany.

Robert S. Barrett was called upon by the War Trade Board, the Department of State, and the Navy Department for various informa-

tion connected with his investigation in South American countries. His intimate knowledge of newspaper conditions and the general commercial situation in South America enabled the Government to deal more intelligently with cases of German activities in Latin America.

H. G. Brock also gave information of no little value on the same lines with reference to west-coast countries of South America.

Nelson C. Brown, during the course of his investigation of lumber markets in Spain, assisted the War Trade Board representatives in that country in connection with the special agreement concluded between the United States and Spain, whereby the American Expeditionary Force in France is furnished with certain essential supplies in return for concessions in the matter of export licenses, bunker privileges, etc. At the request of the War Department, Mr. Brown was later given a brief furlough to enable him to assist the Army engineers in the purchase of railway supplies in Spain. Partly as a result of his visit to Spain and of his intimate knowledge of lumber conditions, the War Department was able to obtain without delay a very large quantity of railroad ties and other construction material.

The information obtained by J. Morgan Clements in his study of Japanese mineral resources has been of assistance to the War Industries Board, the War Trade Board, the Bureau of Mines, the Geological Survey, and the War Minerals Committee. In his future work in China and the Far East Mr. Clements will give particular attention to information especially desired by the war boards interested in increasing the United States's supply of such essential minerals as tin and antimony, for which foreign sources of supply must be relied upon.

G. M. Jones has furnished the Shipping Board with current data regarding port facilities and freight conditions in South American countries, which could have been obtained from no other source.

Axel H. Oxholm has furnished the War Trade Board with data regarding the lumber supplies available in Scandinavian countries and, as the result of his investigation in Finland, made a special report on commercial and political conditions in that country at the request of that board.

The study of crude rubber resources of the world recently completed by Special Agent H. C. Pearson will undoubtedly be of assistance to the war bodies particularly interested in foreign sources of supply for all materials essential to our war industries.

Mr. Rhea's investigation of Chinese railways has been of much assistance in connection with the movement of needed raw materials, and his recent information regarding the operation of the railways of New Zealand, Australia, China, and Japan has been utilized by the Railway Administration.

When conditions in Petrograd became critical Roger E. Simmons, who was pursuing his investigation of the timber resources and lumber trade of Russia, departed for Sweden. The special concessions granted German interests under the Bolshevik treaties promised, however, to have such an important effect on the Russian lumber trade that Mr. Simmons returned to northern Russia for the purpose of following the situation more closely. The results of his investigation of recent developments in the lumber trade and other important

Russian industries will undoubtedly be of great value to the war organizations especially interested in the political and economic rehabilitation of Russia.

The investigation of raw materials in Latin America of W. M. Strachan is of direct interest to the Shipping Board in connection with its allotment of tonnage for Latin American trade, and also to the purchasing departments affected.

The foregoing instances of assistance in the war work of the Government by no means cover all the services rendered by the various special agents during the past year. Practically all of them have submitted special reports dealing with various war problems of the United States, which have been utilized by the various war agencies of the Government. The personal contact of those just returned from abroad with officials of the war bodies has given the latter original information otherwise unobtainable. Finally, it need hardly be said that the published reports of the special agents analyzing the present commercial situation in various foreign countries will be of value in connection with the prosecution of the war, in which economic conditions and shipping facilities are such important factors.

PRACTICAL VALUE OF SPECIAL AGENTS' WORK.

It should not be supposed that the published monographs represent the sum total of the special agents' efforts to extend the foreign markets for American goods. It has already been explained that they give specific advice and, if occasion demands, constructive criticism to particular manufacturers by correspondence and by personal interviews after their return to the United States.

The special agent is in a sense a pioneer of American trade. Particularly in those localities where the import trade is almost exclusively in the hands of European and other foreign houses are the special agents able to do valuable work in bringing American products to the attention of the local dealers. Although the special agents are strictly enjoined from receiving orders for American goods or recommending the products of a particular manufacturer to a foreign buyer, they are frequently consulted in reference to American goods in general. They are often in a position to render good service in explaining the merits of American goods as compared with foreign goods already known in the local market. Many letters of appreciation have been received from American concerns that have received initial orders in this way, or which have, in not a few cases, established satisfactory agencies with foreign importers coming in contact with the Bureau's special agents.

The explanation of the special agents regarding the qualities of American goods have been particularly valuable in the recent past, inability to obtain many lines from the usual European sources of supply having created wide interest in United States products. The special agents have also been able to explain satisfactorily to new importers of American goods the reason for the higher prices, delayed deliveries, and other circumstances due primarily to war conditions. In some parts of the world, notably in certain Latin American countries, foreign competitors have endeavored to make capital out of the fact that prices for American goods were considerably higher than

those formerly paid for similar European products. Similar efforts have long been made to capitalize the alleged failure of American manufacturers and exporters to pack their goods properly. Wherever unjustified criticism of American goods and export methods are made the special agents of the Bureau endeavor to explain the true facts in the case and to counteract the persistent misrepresentations of foreign competitors.

Special circumstances affecting the trade of particular American concerns with foreign importers are reported to the Bureau, which places the matter before the manufacturers in this country. In this way some of the inevitable misunderstandings between exporters and foreign dealers are satisfactorily adjusted. Another practical feature of the special agent's work is the furnishing of information regarding specific openings for American goods which he may observe in the course of his investigation. These "trade opportunities" are a regular feature of the daily Commerce Reports.

The work of the special agent, besides being of interest to the manufacturer already engaged in foreign trade, has a distinct advertising and educative value. His published reports, his addresses before trade associations and chambers of commerce, and the samples of competing goods which he obtains abroad all serve to create an interest in export trade on the part of the manufacturer who has never given serious attention to the subject. The samples of foreign goods and goods of local manufacture sold in the foreign markets under investigation are of real practical interest to American manufacturers, who may be willing to alter their product or change their prices somewhat in order to compete more successfully in an important foreign market.

A striking instance of the value of these samples has just been brought to the Bureau's attention. An electrical wiring device of foreign manufacture was among the sample articles brought back from Australia by the special agent who investigated the Australian market for electrical goods. An important American concern manufacturing electrical goods made a detailed study of this article, which was exhibited in the Bureau's sample exhibit room in New York, and substituted an almost identical article for the wiring device which it had previously attempted to market in Australia. The article was reproduced at a cost slightly below that of the foreign model, with the result that the American company is developing a profitable export trade in Australia.

Two recent examples of very effective business building on the part of the special agents may also be given. The efforts of John R. Walker to induce the British authorities to amend British building specifications so as to allow the use of American standard sizes of lumber have already been briefly referred to. The personal representations by Mr. Walker, together with exhibits of American wood and the tests arranged for by him, seem likely to result in bringing about this change, which will greatly facilitate participation in Great Britain's large after-war lumber trade by United States producers.

During the progress of his investigation in Chile, P. S. Smith was instrumental in having the new Chilean specifications for electrical installations, which were then under consideration, brought more into conformity with United States specifications. The previous specifications had been drawn in accordance with German practice,

with the result that German exporters of electrical goods largely controlled the Chilean market. The demonstration by Mr. Smith of the merits of American electrical supplies to the Chilean experts, with whom he came in contact in the course of his investigation, was responsible for this gratifying change.

That the practical value of the work of the special agents is recognized is evidenced by many expressions of appreciation, a few of which are quoted below as typical. The following is an extract from a letter received from a large Boston manufacturer in reference to an investigation recently concluded:

I have read the portion of the report devoted to the shoe industry with much interest, and consider it admirable in definiteness and clearness with which the ground is covered. * * * Every question likely to arise seems to be specifically answered.

Another recent letter came from one of the largest concerns in Cleveland and contains the following extract concerning the investigation of foreign markets for electrical goods:

We want to say that these two pamphlets as regards our product are the best we have ever come across for general information, and we hope the Department of Commerce, Bureau of Foreign and Domestic Commerce, has in mind the publishing of further pamphlets of this nature on other countries.

The following extract from a letter from the president of an Indiana concern manufacturing railway supplies may also be quoted:

We wish to express our keen appreciation of the splendid work the Bureau is doing in furnishing information of this character. Such data can be obtained in practically no other way by a concern such as ours, which can not afford to send its own men abroad expressly for that purpose.

A firm in Ohio has volunteered the following appreciation of a recent report issued by the Bureau:

This is to refer to Special Agents Series No. 166. Although this letter is not solicited, it seems only right that honor be given to the author and your Department for the wonderful information as brought out in this circular. The writer is very frank to advise that in all of his reading he has never read such an interesting and thorough treatise.

This is just an acknowledgment of the wonderful service that your Department is tendering to such manufacturers as wish to take advantage of it.

The plans for the coming fiscal year have already been outlined. As stated before, reconstruction investigations in European countries will largely engage the Bureau's attention immediately upon the close of the war. Unless the funds available for this work are materially increased, however, it will be necessary to abandon or postpone a number of important investigations. Until the time is ripe for these reconstruction investigations, new work in Europe will largely be confined to the commercial intelligence work already referred to.

In addition to the work in Europe mentioned on page 51 there are a number of investigations in the Far East, Australasia, and Latin America which should be undertaken as soon as funds are available. In the case of the Far Eastern work it is particularly desired to extend some of the investigations recently completed in China and Japan to British India and the Dutch East Indies. Among the market investigations outside of Europe deserving early attention are the following: Construction materials, Far East; hardware, Far East; drugs and chemicals; certain kinds of industrial machinery; machine tools; railway equipment and supplies; store

and office appliances of all kinds; mechanics' tools; motor vehicles, bicycles and accessories; musical and sound-reproducing instruments of all kinds and accessories; miscellaneous rubber manufactures; and perfumery, cosmetics, and soap.

It should not be assumed that the foreign investigations of the Bureau could without loss be discontinued until the end of the war because of the war restrictions and lack of shipping facilities which at present hamper our export trade. The other great commercial nations are keenly alive to the necessity of preparing now to regain and extend their former foreign markets. In Great Britain and Canada this fact is particularly appreciated, extensive new investigations having recently been inaugurated in both countries.

The work of the special agents of the Bureau now in progress and the new work in contemplation will constitute an essential part of the preparation for successful competition by American manufacturers in foreign markets after the war.

DISTRICT-OFFICE SERVICE.

ACTIVITIES CONNECTED WITH THE WAR.

During the fiscal year just ended there were no changes in the number or location of the district and cooperative offices of the Bureau. The year, however, was a momentous one in many respects and the offices accepted in a creditable manner the increased responsibility thrust upon them after the entrance of the United States into the war. Although these offices have long since established their worth in their respective communities, their value to the business men served was brought out in a striking manner immediately after the beginning of the fiscal year. When the President by his proclamation of July 9 required licenses for export of certain commodities from the United States to foreign countries, the Bureau was able to assign immediately to this work a trained personnel in the branch-office service thoroughly acquainted with the business men whom they had been serving for some years, and with whose problems they were intimately familiar.

For approximately seven months of the fiscal year the various district offices of the Bureau continued to handle the work of the War Trade Board. During July and August more than half of the applications for licenses made in the United States were presented at the New York office, and during this period more than 15,000 licenses were granted without the delay that would have occurred had they been forwarded to Washington for consideration.

It is estimated that on several days approximately 2,000 persons applied for export licenses at the New York office alone. While it was inevitable that complaints would be made by business men when the restrictions on the free movement of trade became effective, the ability with which such a situation of extraordinary difficulty was handled by the various district offices did much to create a favorable attitude toward the Bureau and the Government's first step toward the conversion of commercial activities to channels which would aid directly in the successful conduct of the war.

It can thus be seen that the most important work of these offices during the past year, therefore, has been directly in connection with

the measures adopted by the Government looking toward the winning of the war. No opportunity for contributing to the successful outcome of the conflict has been neglected by these offices. With the passage of the trading-with-the-enemy act, in the drafting of which the Bureau had had an important part, many requests were received for advice regarding the interpretation and scope of the measure. A number of the business houses whose former representatives were placed on the enemy trading list, particularly in Latin America, appealed to the district offices for assistance in obtaining new connections. In these matters the district-office managers and assistants were able to bridge many of the difficulties which had arisen in the everyday commercial transactions of the country. In addition to enforcing the regulations above noted, the district-office employees have acted in an intermediary capacity in assisting business houses throughout the country to adjust their manufacturing and business operations to the regulations of the various departments of the Government, whose decrees tended to check or change the normal flow of commerce. Announcements by the Railroad Administration, the Fuel Administration, War Trade Board, Food Administrator, and other Government organizations have been brought to the district offices for analysis or explanation, and in many cases for at least a partial enforcement. Not only have the district offices been appealed to for assistance in conforming to the important orders and regulations of these bodies, but they have been equally active in harmonizing the indirect effects of such orders.

By means of letters, conferences, addresses, and press announcements the district-office managers in no small measure convinced those firms and individuals engaged in the country's commercial enterprises of both the justice and wisdom of the Government's decisions and proclamations. The activities of the district offices have been confined not alone to the American Government's control of industry and commerce, but they have brought to the attention of the business communities the true meaning and extent of the regulations of practically every other country in the world.

Special investigations were made on behalf of various branches of the Government, because of the abnormal conditions incident to war time. This was necessary in the case of difficulties arising in connection with foreign shipments, where not only the regulations of our Government, but those of foreign Governments, changed the natural course of trade. The district offices have been instrumental in adjusting satisfactorily to the various interests involved most of these difficulties. They have proven equally valuable in securing the special information of various kinds required for the proper guidance of important work undertaken by Government headquarters in Washington.

FOREIGN-TRADE PROMOTION.

The activities of the district offices were not confined entirely to war-time work. In spite of the war work assumed the offices succeeded in maintaining to an unusual degree their normal activities in connection with the promotion of foreign trade and the distribution of information to interested houses. In fact, the volume of "regular work" in many of the offices increased. Many firms here.

tofore engaged solely in domestic trade, whose markets have been curtailed by the changed conditions, turned to foreign fields for relief from their difficulties, and have naturally looked to the district offices for assistance in inaugurating their foreign-trade campaigns. That American business men are anxious not only to maintain the trade which they have already secured, but also to increase this trade, is evidenced by the fact that during the year the district offices received and answered over 100,000 letters and distributed several hundred thousand "Foreign Trade Opportunity" notices.

The district offices during the past year have had to do with domestic trade more deeply than ever before. Owing to the taking over by the Government of the production of many factories, private purchasers have been forced to look about for new sources of supplies. In furnishing names and locations and nature of such new connections the district offices have served a most useful purpose.

The work of the district offices necessarily has for one of its main features that of educating the public to the uses of the Bureau's facilities. The usual mediums through which this educational work is conducted are commercial organizations, libraries, educational institutions, the establishing of classes in foreign-trade instruction, and similar organizations.

Practically every district-office manager during the past year has conducted a foreign-trade course in one of the educational institutions in his district. The personnel of these classes consists of the representatives and many of the heads of the principal business firms in the country. The meetings are usually held in the evening, and in addition to the regular lectures and examinations, round-table meetings are held periodically. Experts along particular lines usually attend these meetings, and when a financial subject is under discussion, for instance, a banker of recognized ability presides; when a shipping question is under discussion, a leading shipping man, and so on. To such an extent are these meetings attended that the various phases of foreign trade, together with a thorough knowledge of the Bureau's activities, are brought to the attention of the leading men interested in the subject in a practical manner.

Probably the most important work is conducted through conferences, which are held usually in the office of the district-office manager or the headquarters of a commercial organization located in his district. The cooperation which has existed between the district offices and the commercial organizations in their territory during the past was noteworthy in the fiscal year under consideration. This cooperation is of mutual advantage to the commercial organizations and to the Bureau. Such questions as markets to be exploited, changes in Government regulations, information regarding trade-marks in foreign territories, and many other up-to-date questions are handled with good results.

This work is not confined entirely to cooperation with commercial organizations, but is continued through addresses to various gatherings in the territories served by the district offices. Hardly a week passes when the district office manager does not deliver one or more addresses to some representative gathering in his community. These addresses establish close working relations with the people interested in the work which the Bureau and Department are carrying on, and

necessarily exert a beneficial influence in the community. Almost without exception, district-office managers are requested to serve on the foreign-trade and other committees of organizations engaged in the practical work of foreign trade.

SPECIAL WORK OF DISTRICT OFFICES.

Among the special tasks handled by these district offices during the last year may be mentioned the successful conclusion of negotiations by the district-office manager in New York for the return of the bonds filed with the Russian commercial attaché under the protocol entered into September 23, 1915. Bonds amounting to approximately \$20,000,000 were received from the Russian attaché and were returned to the firms by whom they had been filed upon receipt of affidavits indicating the disposition of the goods in question and their consumption in the United States. The return of the bonds was carried out to the entire satisfaction of all concerned. Another special incident of the year was the detailing of the district-office manager at San Francisco to accompany the Imperial Japanese Government Railway Commission on its tour through the United States in October and November, 1917. Stops were made at all the principal railway centers between San Francisco and New York. Every courtesy and facility were given by the railways to enable the Japanese to see the practical working of the American railway organization.

One of the features contributing materially to the success of the district-office work is the conferences between trade commissioners, American consular officers on leave of absence, and the business men of the country. The district-office manager is peculiarly fitted to bring together these returned officials and the merchants who are especially interested in the countries in which the officials have seen foreign service. Business men appreciate the opportunity to secure first-hand information regarding actual business conditions in foreign countries. It is hoped that the practice which has been carried on successfully for the last several years will be enlarged in the near future, and that returning Government officials may make more extended trips throughout the country and be allowed to give more freely of their time to work of this character.

Another important feature of the work of a district office is the introduction of foreign buyers to American business men producing the articles required for foreign consumption. Many letters have been received from such foreign buyers reporting the value of the services rendered by the district-office managers during the past year in enabling them to form desirable connections. Although the war undoubtedly curtailed the number of such buyers, especially from European countries, nevertheless the number of foreign buyers showed a satisfactory increase over previous years, and this feature of the district-office service is bound to occupy a prominent place upon the conclusion of the war and the return to normal conditions.

PERSONNEL AND ORGANIZATION.

The changes in the personnel of the district offices have been rather numerous during the year. The causes for these changes were, first,

the enlistment and induction of a number of men into the military service of the country, and, second, the inadequate salaries paid to the men for the class of service performed. It was inevitable that many of the employees of the district offices would enter the military service, and the Bureau made arrangements for filling their places with the best material available. The question of salaries for men in the district-office service has been acute for some time, and if the Bureau hopes to keep up the standard of these offices provision must be made for allowing these employees compensation approaching, at least in a slight degree, the salaries paid men in their respective communities who are doing a similar class of work.

In the New York office, for instance, which is the most important office of the Bureau, during the last year four different men were in charge at various times. This was due almost solely to the fact that the salary paid the men in charge of this office was too low. The salaries paid these men have not kept pace with the increased salaries paid throughout the country to men who are doing work of a much inferior quality and upon whom the demands are not so great as upon our district-office employees.

Another weakness of the district-office service, so far as the personnel is concerned, is that with rare exceptions there is no second man in the district office approaching the qualifications of the man in charge. This is a serious handicap to the district-office manager in properly carrying on his work, and is a particular hardship upon the Bureau when a change takes place in the managership of the office. At the present time many of the district-office managers are required to spend too much of their time in the office devoting their energies to routine work which could be performed as well by lower-paid men. The district-office manager should spend the major portion of his time outside his office in handling bigger problems and carrying on the work for which these offices were created.

In order to do this work successfully, provision should be made for increasing the force of all of the district offices materially during the coming year. In addition to increasing the personnel of the present offices maintained by the Bureau, at least five additional offices should be established, as there are at present that number of cities in the country in which the business men could be better served by a district office of the Bureau. Additional cooperative offices should also be established in cities which now have live commercial organizations, but where the demand for foreign-trade information is not sufficient to warrant a separate budget for maintaining a department of this kind. With some slight modifications in our present agreement for the establishment of such offices, it is believed that a number of commercial organizations in important industrial centers of the country will be glad to avail themselves of the privilege of establishing cooperative offices.

Another feature which might properly be termed district-office service is worthy of mention, namely, the appointment of at least two commercial agents at large, who will spend the greater part of their time traveling throughout the country conferring with business men, carrying the services of the Bureau right to the factories and mercantile houses. The practical nature of this work was demonstrated by the appointment of a commercial agent of this

character several years ago, who visited a limited portion of the country, and the results of his trip were so satisfactory that it is believed the Bureau would be warranted in making an appointment of at least two agents of this character to continue the work which was begun some time ago by the official referred to. These agents, it should be understood, would make their headquarters at the district office in the territory through which they were traveling. They would also be available at all times for any special investigations, interviews, and reports which the Bureau might desire undertaken in cities in which the Bureau now has no district office.

EXHIBITION OF FOREIGN SAMPLES.

An important and valuable service is rendered to American exporters and manufacturers through the sample room maintained at the New York district office of the Bureau in room 734 of the United States customhouse. Here samples of various kinds of foreign-made goods sold in the principal importing countries of the world are displayed, accompanied by detailed information as to the markets in those countries. These exhibits, after being shown in New York, are usually sent to the principal centers of the particular industry involved for examination by those who are unable to see them in the main exhibit room. The whole idea back of the foreign-sample work is to bring the articles being sold in foreign markets to the attention of American exporters, in order that they may have definite and reliable data regarding the goods with which their wares must compete. These samples are collected by the special agents of the Bureau, its commercial attachés, and the American consuls. Complete reports, giving all available information on the particular foreign market for the class of goods under consideration usually accompany the exhibit.

The permanent sample exhibit was started by the Bureau in September, 1915. The first display consisted of hardware samples from nearly every country in the world, the total number of samples running well into the thousands. The quarters were at first entirely inadequate, but the work was continued in the best manner possible until a better location was secured. Display frames and tables for showing the goods were obtained, and the hardware exhibit attracted attention at the time among manufacturers and exporters of this class of goods.

Textile samples from a number of countries were added to the exhibit later, as well as wearing apparel and miscellaneous items. These were, of course, of especial interest to textile manufacturers and dealers. The various kinds of exhibits gradually increased, thus necessitating still larger quarters, and the sample room was finally moved to the seventh floor of the New York customhouse, where it is now located.

Since January 1, 1918, the work of classifying and arranging the samples that had accumulated and new articles continually being received has been vigorously pushed. The exhibit room is now rapidly being put into shape and its activities will soon be much extended.

At present there are on hand samples of the following classes of goods from the countries mentioned:

Electrical goods from Cuba, Porto Rico, Australia, New Zealand, Japan, China, and Siberia.

Wearing apparel from Japan, China, Chosen, Siberia, Australia, Straits Settlements, Dutch East Indies, Cuba, Peru, Bolivia, Ecuador, Chile, Argentina, and Brazil.

Cotton goods from practically every country in the world. Sample books have been prepared containing several thousand samples of textiles that are very valuable to exporters.

Woolen goods from a number of foreign countries, including Chile and Argentina.

Musical instruments from Brazil.

Paper and paper products from all South American countries. This exhibit is very complete and shows exactly the grades and qualities of paper that are used in these markets.

Hardware from a number of countries. This is a part of the old hardware exhibit, and some of the samples are now somewhat out of date.

Ecclesiastical goods from South America.

Paints and varnishes from Brazil.

Fancy groceries and canned goods from South America.

Stationery used in South America.

Jewelry and silverware from Cuba, Peru, and Bolivia. This exhibit will include all South American countries when completed.

Surgical instruments from South America.

Boots and shoes from Australia, New Zealand, the Philippines, Cuba, and all South American countries.

Tanned leather and tanning bark from the Far East.

Publications and exhibits relating to railway equipment and supplies in the Far East.

A considerable range of these articles is represented in the Bureau's exhibit and all are available for inspection. This service is supplemented by American and foreign statistics and reliable trade information as to the demand for the products in foreign countries, the home production, and notes as to the popularity and demand for certain styles and qualities, tariff information, etc.

An important use of the samples is in connection with the conventions of the larger trade associations. During the past year the Bureau has had special exhibits at the following conventions: Southern States Exposition, Hotel Astor, New York, October, 1917; National Boot and Shoe Manufacturers' Association, Hotel Astor, New York, January, 1918; New England Shoe and Leather Association, Boston, Mass., February, 1918; National Foreign Trade Council, Cincinnati, Ohio, April, 1918; Textile Exhibitors' Exposition, Grand Central Palace, New York, May, 1918; National Tanners' Association, Atlantic City, N. J., May, 1918; and Pilgrim Publicity Association, Boston, Mass., June, 1918. The display of samples at these conventions undoubtedly has been of much value in bringing to the attention of our exporters this important line of Government service to trade.

Another feature of the New York exhibit room is a carefully indexed file of foreign catalogues, consisting of several thousand different publications. These catalogues are indexed by subjects and countries so that all the volumes relating to any particular subject are readily available. They serve a useful purpose in giving prices and illustrations of foreign goods. A number of German general export catalogues on file have attracted much attention from firms that send catalogues to foreign countries. Ideas obtained from these foreign

catalogues have been incorporated into the publications of several American concerns.

Representatives of many manufacturing and exporting firms have expressed their appreciation of the information obtained through an examination of the Bureau's samples. A firm in Connecticut making electrical supplies sent a man to New York for the purpose of going over the samples from the Far East, and this concern is now making a number of the items similar to those shown in the exhibit of goods used in Japan. Exporters of textiles are continually being supplied with clippings of fabrics sold in foreign countries, thereby eliminating the delays incident to sending for samples before filling orders. The head of the wearing-apparel department of a large New York export house stated a short time ago that he had obtained many ideas as to styles and qualities demanded by South Americans that were of much assistance to him in buying goods for export. In a number of instances the foreign exhibits have been of value to firms making their first trial in sending goods abroad.

It is planned to circularize all firms that may be interested in each particular group of samples. In addition, write-ups of the exhibits are sought by trade journals and newspapers. In this way every manufacturer and exporter will be acquainted with the facilities offered by the Bureau for the inspection of samples and the distribution of trade information concerning them, and through this wider publicity it is hoped to increase to a great extent the value of this service to our exporters during the coming year.

LATIN AMERICAN DIVISION.

TRADE PROMOTION.

Although the Latin American division has devoted much time during the last year to the important commercial work having a bearing on the conduct of the war, the fundamental purpose of trade promotion has by no means been neglected. The restrictions upon foreign trade through the curtailment of shipping space and export and import license requirements have obviously retarded our trade with Latin America in many respects. This, however, has not applied uniformly throughout that region. For example, the trade with nearer regions of Latin America, notably Central America and northern South America, has been considerably stimulated, owing to the impossibility of importing certain commodities from the islands of the Far East and from more remote regions of Latin America.

In anticipation of requests of American exporters and importers for assistance in trade with the Caribbean countries, the division has undertaken detailed investigations of certain resources and trade problems in those countries. Among topics in this field that have been covered are the following: Colombian platinum; cacao production; the coconut industry; cattle-raising possibilities in Central America, Colombia, and Venezuela; transportation in Colombia; and vegetable dyestuffs. The results of these studies have been called to the attention of American trade interests through correspondence and by publication in Commerce Reports and in the Latin American Circular.

During the latter part of the fiscal year the number of Latin American trade investigations and inquiries handled by the division averaged over 400 a month. A gratifying response to this stimulation has been observed in the activities of American houses in that field and in their requests for further assistance in their investigations of special problems.

As an encouragement to independent investigation by commercial houses, the division has prepared a large number of bibliographies and timely lists of selected reference material on Latin American trade problems in different lines. These lists are being distributed through the district offices and by correspondence. The topics covered thus far include Latin American trade aspects in the following lines: Automobiles and motor trucks, casein, cinchona bark, coal, coffee, copper, dairy products, drugs and chemicals, fibers, furs and fur-bearing animals, investments, jewelry and silverware, manganese, musical instruments, nitrate, oils (vegetable), rubber and rubber goods, sisal, tin, and wax (vegetable).

A few illustrations will be cited as indicative of the character of trade-promotion investigations conducted through the division:

Brazilian market for railroad supplies.—It was learned that the Director of the Brazilian National Railways was interested in securing data on the operation of American railway lines and on the standards of railway supplies. The matter was called to the attention of various railway officials in this country, and as the result of their hearty cooperation, the division was able to transmit to the Brazilian railway officers a large quantity of material bearing on these subjects. This seems to have been of service to the railway administration of the southern Republic, and it is hoped that favorable results may be looked for in our future trade in railway equipment and supplies.

Brazilian market for industrial equipment.—One remarkable effect of the war upon Brazil has been the marked stimulation of its industries, and every effort is being made to insure a permanent survival of the important industrial enterprises which have arisen since 1914. A large industrial school is to be established in Rio de Janeiro upon plans drawn up by an American expert in the field of industrial education. The Latin American division has been actively cooperating in the preparation of these plans and it is hoped that equipment of the school along American lines will be both satisfactory to the Brazilian authorities and ultimately helpful to American industrial machinery interests.

Improved cable service with Latin America.—Assistance has been rendered from time to time during the year to promote better communication service between the United States and Latin America. This work has taken the form of seeking out and exploiting opportunities for inter-American wireless stations, of suggesting cable rate modifications, and of assisting in the installation of cable service.

Reconstruction opportunities in Mexico.—The gradual reestablishment of order in Mexico is stimulating an increasing interest in American exporters, many of whom have been deprived of their more remote markets through war restrictions. In order to render reliable and practical information service in the Mexican field, the division has been building up its files of data on trade conditions and resources in that Republic, and through the valuable assistance of Mexican Government offices and of private firms, a considerable quantity of data has been gathered which deals with such subjects as the rehabilitation of Mexican industries, railways, and mining enterprises, agricultural reconstruction, and certain aspects of the labor problem.

A few illustrations of the type of inquiries coming to the Latin American division may be of interest:

What are the forms of theater chairs used in Brazil?

What is the normal distance between rows of cotton plants in Peru?

What types of containers are used in the Guiana sugar trade?

What are the forms of flavoring extract labels and bottles in the Buenos Aires market?

What ships in the merchant marine of the Latin American countries are equipped with refrigeration space, oil tanks, dredging apparatus, etc.?

What types of hoisting apparatus are in demand in various Latin American mining regions?

What are the agricultural products and labor supplies of certain interior sections of Brazil?

By far the greater proportion of the inquiries received come from smaller concerns whose experience in or knowledge of Latin American trade is quite limited. Recently, however, it has been gratifying to note an increasing number of requests coming from larger concerns with extensive interests and connections in Latin America. In such cases, as a rule, the division is called upon to assist in the extension of the activities of the firm in question into new regions or in new lines of trade. Such larger firms have shown a very cordial spirit in placing at the disposal of the Bureau valuable information upon Latin American affairs which was not readily accessible to Government offices.

The following are extracts from letters of appreciation received by the division during the year.

From the president of a large Missouri corporation interested in lumber, bricks, tiling, etc.:

This is written as a personal letter thanking you for your explicit instructions and the trouble to which you have gone in order that this information, which is of value to us, might be obtained with the least trouble to us. While our respect has always been great for the Department of Commerce, your present service has raised it to the nth degree.

From a Seattle lubricating-oil manufacturer:

We have established an agency in Chile and are about to open a factory in Brazil as the direct result of active cooperation from the Bureau's Seattle office and from your division.

From a Chicago commission house:

We wish to thank you for the painstaking way in which you have covered our inquiry. We have already had abundant opportunity to realize that your Department is back of us to the very limit.

From a former Assistant United States Attorney General:

In the light of about eight years of experience as a Government official in Washington, I feel that it is only fair to place on record my opinion that I have never met with a finer spirit of cooperation all along the line than I did on this occasion. [Investigation leading up to shipment of an important material for war purposes from Mexico.] Frankly, I must say that the much-talked-of red tape was conspicuous by its absence, and if I should hereafter find any evidence of it I should feel justified in presenting it to the Smithsonian Institution as a rare specimen of what now appears to be an extinct species.

From a New York paint manufacturer:

To give you an idea of the importance of the market for paints, we may state that in Ecuador, Peru, and Bolivia the writer sold in 1917 approximately \$120,000 worth of pigment paints and linseed oil. In the Republic of Chile alone his sales amounted to over \$250,000 for the same commodities. These countries afford a wonderful opportunity for the American manufacturer, and we are especially indebted to the great assistance rendered to us by the Bureau of Foreign and Domestic Commerce, through its commercial-attaché's service. The Department of Commerce, as a whole has encouraged us; given us much valued information that we believe our success mainly due to the preliminary work which this Department has done in preparing the market for American merchandise.

From a New York electrical supply manufacturer:

On the basis of data supplied by the Latin American division regarding specifications for tubing for electric wiring in Chilean and Argentine markets, this house is manufacturing 200,000 meters of such tubing for the South American trade of a large American commission house.

From the president of a middle western commercial college:

There is great satisfaction in being a citizen of a country where a civilian may secure such courtesy and favor as that exhibited by your kindly action in forwarding to us such reports on the trade in certain lines between the United States, Cuba, and the Latin American countries.

PUBLICATIONS.

One of the difficulties encountered by the Latin American division was the problem of giving adequate circulation to the information collected in the course of various trade investigations. Such studies frequently brought together a quantity of data which would be useful to firms interested in the Latin American field. In order to reach such trade interests, a mimeographed "Latin American Circular" has been issued at approximately weekly intervals. It was originally intended to reach the export and import houses of the country, through the district offices of the Bureau, but the interest manifested in the circular soon made necessary a wider circulation. Its mailing list now includes about 400 trade journals, chambers of commerce, and larger banks and foreign-trade firms whose interests come in contact with many aspects of Latin American trade.

The "Commercial Travelers' Guide to Latin America," mentioned in the last annual report of the Bureau, which is being prepared by E. B. Filsinger, has been completed and will appear in the fall of 1918. It will include a quantity of information gathered from a wide range of sources not readily accessible to the average traveler. The topics covered include data on equipment, railroad and steamship service, recent actual expense accounts of travelers, license fees, hotel accommodations, suggestions for reading, etc.

Another form of publication, in the preparation of which the Latin American division has taken part, has been a series of handbooks to be published by various trade organizations whose members are interested in the Latin American field. These handbooks are to be issued in Spanish and in Portuguese along the lines of similar publications already in circulation. The division is cooperating in this work by supplying data, making suggestions on the form and contents of such publications, and by compiling proper mailing lists and arranging for distribution through commercial attachés and other officials.

LATIN AMERICAN FILES.

The first prerequisite for a satisfactory information service in this field is obviously a complete equipment of reliable sources of trade data. A considerable amount of time and funds has, therefore, been spent in the course of the year in building up the file equipment of the Latin American division. A large number of detailed maps have been collected, with special reference to such subjects as mineral resources, transportation facilities, concessions, vegetation, etc. A

special effort has been made to collect reports of American and foreign companies having properties in the Latin American field, and the files of the division now contain printed and other statements of more than 300 enterprises of this sort. About 110 Latin American and European newspapers and magazines are indexed and clipped for information upon trade conditions in the southern Republics. A bibliography containing about 20,000 cards, which is growing at the rate of more than 1,000 cards monthly, is also a part of the equipment of the division. The library of the division contains about 1,000 volumes and pamphlets bearing upon subjects in this field. Contact is maintained with the publication offices of the Latin American Republics and with the various bureaus in Washington so as to build up as complete a collection of official source materials as possible.

WAR WORK.

While the chief function of the Latin American division in normal times has been the collection and dissemination of data on Latin American trade conditions for the benefit of American exporters and importers, a large part of the time of the division during the past year has been devoted to assistance rendered to the various war offices whose interests have touched upon Latin American affairs. This important task, although not contributing directly to the promotion of commerce, has nevertheless frequently taken the form of representing American export and import interests and of assuring for such war policies as involve Latin American commerce an adequate basis of accurate information upon actual trade conditions.

In fulfilling this purpose the division has been called upon to supply quantities of data in the form of memoranda, reports, and statistical tables for such war offices as the Shipping Board, War Trade Board, Navy and War Departments, War Industries Board, Red Cross headquarters, and the Committee on Public Information.

In most cases these tasks have been given precedence over others, and the data furnished have afforded in several cases a basis for determining the Latin American economic policies of the Government. Most of this work has been done for the War Trade Board and the Shipping Board. The amount of time spent on these assignments ranged from an hour or two to seven or eight weeks, each member of the division at one time or another being engaged on war work. The average weekly time of the division staff in this work has ranged from 12 or 15 to 90 or 100 hours. On one assignment for the Shipping Board two members of the division spent most of their time for the better part of a month, and others have taken up several days.

The Shipping Board, in working out its plans for the allotment of ship space, wished to have full data as to the shipping space taken up by each class of commodities imported into the United States. This information was worked out for the desired periods of years. When the Shipping Board found necessary the restriction of the importation of certain important tropical products it also considered steps to assist the growers in readjusting themselves to the new conditions so as to avoid as much as possible the loss of capital and the unemployment of labor which would naturally result. The Bureau volunteered to have a member of its staff go to Central America,

Colombia, and the West Indies to see what could be done in the way of readjustments, and the division has actively assisted him in preparing for his investigation.

The War Trade Board adopted a policy of sending abroad special agents to engage in commercial investigations directly connected with war-time restrictions. In preparation for their missions the agents assigned to Latin America spent considerable time in the division, going over its files, making copies of reports, etc.

The research carried on by the War Trade Board in this division has been so varied and extensive that that organization has found it advisable to have a research clerk stationed here permanently. This clerk has been provided with desk room, and is cooperating constantly with the division in compiling reports on Latin American topics.

The Signal Corps, requiring supplies of important raw materials from Latin America for its work, called on this division for information as to amounts available. After supplying all data in our files we obtained cable and mail reports from certain consuls in Latin America and took up the subjects with the Bureau's New York office, getting two or three reports containing information obtained from importers and manufacturers. We have had frequent occasion to assist the Signal Corps in other ways in getting adequate supplies of these products from Latin American sources.

The Council of National Defense has interested itself in getting supplies of raw material from Brazil, and the division has been represented in several conferences on the subject. The division also worked for some weeks in cooperation with an American company controlling raw materials in Mexico, in an effort to free the importation of these products from various restrictions placed upon them.

The Federal Reserve Board called upon the division for a detailed study of the exchange situation in each of the more important South American countries. The results of this study were used in the preparation of plans for the stabilization of dollar exchange in those countries. By the close of the fiscal year the investigation had covered the situation in Argentina, Brazil, Chile, and Uruguay, and work is being continued upon the remaining countries. This investigation was in charge of J. H. Williams, an expert in the field of foreign exchange, who has recently made an extensive study of the situation in Argentina. The more important conclusions of this study have been called to the attention of American export and banking houses, and in response to their encouragement it is planned to publish a report upon the whole problem of Latin American exchange and its bearing upon American export trade.

PLANS FOR THE COMING YEAR.

The program for the Latin American division for the coming year gives promise of considerable development and expansion along the lines followed during the past few months. War work is likely to figure quite as conspicuously, and the calls for extensive researches will probably increase as the growing facilities of the Bureau in the Latin American field are more widely known and utilized both by Government officials and by trade representatives.

In order to meet these demands for information on Latin American affairs, the division is in immediate need of additional expert research assistance. It is hoped that two or three trained investigators may soon be added to our staff to undertake this important work.

This additional help will make possible certain very necessary improvements in the publication service of the division. Considerably more material can then be prepared for Commerce Reports, and more extensive timely memoranda on trade conditions can be drawn up for circulation through correspondence.

It is planned to broaden the scope and usefulness of the Latin American Circular by extending the mailing list, by enlarging the individual numbers beyond their present condensed form, and by increasing the frequency of issues so as to keep the American exporter and importer informed of as wide a range of up-to-date Latin American trade data as possible.

Furthermore, the division is to prepare at least two larger publications or reports. One of these will deal with Latin American exchange and the war, and will be a compilation and enlargement of the Latin American Circulars now being issued on that subject. The other will summarize prewar German commercial interests in Latin America, with a view toward anticipating the possible lines and character of German competition after the war.

FAR EASTERN DIVISION.

During the fiscal year 1917 the work relating to the Far East was not handled by a separate division of the Bureau, but was taken care of by a member of the staff (with certain clerical assistance), under the general supervision of the chief of the research division. In October a clerk who had been stationed in Peking was assigned to the task, and entered upon the organizing of a separate reference library and a clipping file of newspaper and magazine articles relating to trade with the Far East. A card index was also started giving references to articles in current periodicals. These files have proved of assistance to the business community, as well as to research workers from the War Trade Board, the Shipping Board, and other organizations in search of data along particular lines.

An appropriation has been granted by Congress to build up an efficient organization for handling far eastern matters along lines that have already won approval in the Latin American division. This appropriation became effective July 1, 1918, but plans were well under way in June and an expert selected to carry on the work.

It has been arranged to centralize all matters relating to the countries of the Far East and to have assistants who will specialize for each of these countries. Additional clerical assistance has been provided to take care of the extra work, and steps have been taken toward securing experts in Japan and the Philippines to handle inquiries relating to trade with those countries. Interviews have been held with manufacturers, exporters, and bankers interested in far eastern trade to acquaint them with the Bureau's plan for the extension of its work relating to the Far East and to lay before them specific opportunities for investments or for increased sales of goods.

The far eastern division is called upon more and more by representatives of various war boards whose work requires special studies

of the shipping and particular phases of trade in the Pacific, and the division is increasing its collection of books, periodicals, and Government publications in order to be of increasing usefulness to all interested. In view of the situation in Manchuria and Siberia, the division's activities should have a useful and important influence in helping to shape business policies with respect to that portion of the Far East.

DIVISION OF FOREIGN TARIFFS.

The work of the division of foreign tariffs has naturally been affected by the war activities of the Bureau, as well as of outside organizations, particularly the War Trade Board and the Shipping Board. The division is now recognized as the source of information regarding foreign Governments' trade restrictions, such as export embargoes and import prohibitions, and requests for such information have formed a conspicuous feature of the division's correspondence. The war activities of the Bureau and the growing interest in reconstruction problems have also served to widen the scope of the tariff division, so as to cover not only the phase of reconstruction dealing with tariff policies but also with many other phases of commercial life. As a result of research work along the lines of reconstruction problems in the most important belligerent countries, the division was in a position to contribute an extensive memorandum on the subject for the bulletin entitled "Economic Reconstruction," published by the Bureau in September, 1918.

COOPERATION WITH OTHER DEPARTMENTS.

There has been very close cooperation between this division and the office of Foreign Trade Advisers in the Department of State in regard to the publication work of the division. A number of conferences have been held with the adviser on commercial treaties in the Department of State, and, while the division was not in a position to comply fully with the request for preparatory work on commercial treaties, it prepared some memoranda with outlines for the required investigations. The division has also prepared for the Department of State a confidential memorandum on a plan for the control of exports of Russian foodstuffs, and has succeeded in getting that Department to make representations in connection with attempted piracy of American trade-marks in foreign countries. The Department of State has sent out instructions, at the request of the division, for consular reports on the governmental regulations on patent medicines in Latin American countries and the marking of jewelry in a number of important foreign countries. These reports have been made available in manuscript form to organizations and individuals, and it is expected that they will be ultimately published.

The members of the staff of the Tariff Commission have made use of the files of the division of foreign tariffs, and a number of special memoranda have been prepared for that organization. Conferences have also been held with members of the commission's staff on the subject of free ports, regulations for the administration of the anti-dumping provision, commercial treaties, etc.

The Bureau of Chemistry of the Department of Agriculture has been collecting material on foreign pure food and drug laws for a

number of years and plans eventually to take over the work of answering inquiries on the subject, which is now being done by the division of foreign tariffs, with rather inadequate material and technical equipment. The division continues to publish material on the subject in Commerce Reports.

The division has been called upon for much information by the War Trade Board and the Shipping Board, largely in the form of memoranda on embargoes and import prohibitions in foreign countries. The Council of National Defense has also made use of the files of the division, especially in connection with material on reconstruction. One report on the tariff relations between Germany and Russia was subsequently published by the Bureau as Tariff Series No. 38. In addition to this report, a memorandum was prepared giving an analysis of the economic provisions of the Brest-Litovsk treaty.

PUBLICATION WORK.

The publication work of the division of foreign tariffs consists of contributions to Commerce Reports and special monographs. The contributions to Commerce Reports during the fiscal year amounted to nearly 280 pages, reassembled and published in four bulletins—Foreign Tariff Notes Nos. 26-29. They included, in addition to notes on foreign tariffs, trade-mark laws and trade restrictions, articles dealing with the effect of the war on commercial policies, the economic features of certain parts of Russia, report of the Lord Balfour Committee on Commercial and Industrial Policy After the War, etc. The monograph work consisted of the customs tariff of Austria (Tariff Series No. 37, 104 pp.), Tariff Relations Between Germany and Russia (Tariff Series No. 38, 23 pp.), and British Control of Imports and Exports (Tariff Series No. 39, 32 pp.). In general the publication work of the division reflects the widened scope of its work as a result of the war.

FOREIGN TRADE-MARKS.

Probably no other part of the division's work is productive of so much good will for the Bureau as that done in connection with trade-mark piracy. The notifications sent out when evidences of attempts to appropriate American trade-marks are discovered in foreign, particularly Latin American, official publications have brought many replies expressing appreciation of the initiative of the Bureau, and some of the trade-mark attorneys who have visited the Bureau as a result of notices sent to their clients were rather pleasantly surprised at the extent of this trade-mark work. While there is sufficient evidence to show that as a result a number of American trade-marks have been prevented from falling into the hands of pirates, it is believed that much more valuable results have been accomplished in calling the attention of American business men to the necessity of trade-mark registration in foreign countries. The correspondence in connection with the trade-mark work has increased considerably during the year and the sending out of notifications about trade-mark piracy has been facilitated by the use of a special form letter. As a result of rumors about a concerted movement on the part of Germans

in Latin American countries to register American trade-marks, the Department of State, at the request of the division, sent out circular instructions for special reports on the subject. While no definite confirmation of the rumor has been received, there have been a number of cases of applications by persons with German names for the registration of groups of American trade-marks in some foreign countries. In some cases the owners of American trade-marks in these countries have been placed on the enemy-trading list, with the result that the trade-marked product was practically excluded from the market. Representations have been made to the Brazilian Government for the annulment of such trade-mark registrations as a war measure. Representations have also been made to the Argentine Government for a change in the trade-mark law or administration that would put a stop to the frequent appropriations of American trade-marks in that country. The opening of the Habana bureau for the registration of trade-marks in the northern group of countries which have ratified the Pan American Trade-Mark Convention will greatly facilitate the work of registering American trade-marks in those countries, and the division has made a special effort to acquaint American business men with the provisions of the convention through correspondence and notices in Commerce Reports.

MISCELLANEOUS WORK.

The lack of parcel-post conventions between the United States and a number of important Latin American countries has been brought to the attention of the Bureau on numerous occasions, and the recent abrogation of the convention with Chile, on account of disagreement as to the method of payment, has aroused strong protests. The subject has been brought to the attention of the Post Office Department and the International High Commission and negotiations are now in progress for a new convention with Chile.

Foreign trade restrictions resulting from the war still form the subject of a good share of the division's correspondence, although the restrictions adopted by the United States have somewhat lessened the complaints against similar measures on the part of the allies. In order to facilitate answering inquiries about the British restrictions, a special compilation was issued on the subject as Tariff Series No. 39, entitled "British Control of Imports and Exports." The material on the subject collected by the division has been augmented by the addition of foreign compilations and official and semiofficial documents, and it is believed that this collection is probably the most complete in the country.

RESEARCH DIVISION.

The work of the division of research consists in the preparation of the Statistical Abstract of the United States, detailed statistical studies, based on the official statistics, of the exports and imports of foreign countries, researches in the official publications of foreign countries relating to trade and commerce, short statistical compilations for departmental, congressional, or commercial use, translations, the reading of foreign trade journals for items of interest to American manufacturers, the preparation of the pamphlet on whole-

sale prices in the United States, and researches for articles for publication in Commerce Reports, for other divisions of the Bureau, and in response to other official and individual requests.

STATISTICAL COMPILATIONS PUBLISHED.

Three publications have been prepared in the division during the year: The "Statistical Abstract of the United States for 1917," the pamphlet entitled "Wholesale Prices," and "Furniture Imports of Foreign Countries." In addition, numerous other statistical tables were prepared for the publications of the Bureau, the most voluminous being the statistical material in Miscellaneous Series No. 65, "German Trade and the War."

The statistical publication showing the furniture imports of foreign countries gives the quantity and value of imports of furniture into all countries whose total annual purchases amounted to over \$500,000. Notwithstanding the fact that the study was limited to countries importing more than half a million dollars' worth, statistics for 16 countries are given in this publication. The total value of the imports of furniture into all the countries considered amounted to \$19,691,705 in 1908 and \$30,954,931 in 1913. The value of the imports reported as coming from the United States amounted to \$3,503,598 in 1908 and \$6,074,083 in 1913. While many countries use arbitrary rates in the valuation of imports, the figures given above, which are in many cases less than the true values, show the important part occupied by the furniture business in the foreign trade of the world and the large share of the United States in that trade.

SPECIAL STATISTICAL WORK PLANNED.

- During the coming fiscal year a part of the force of the division will be kept continually at work on statistical compilations of this character. These studies will give statistics for all countries whose annual imports exceed \$200,000 and will give figures for 1908, 1913, and the latest period for which comparable figures are available.
- They will thus show the development of the trade of foreign competitors in the various markets of the world during the five years preceding the war, and will also indicate the changes and adjustments in international trade resulting from the scarcity of shipping and the disturbance of industry since the beginning of the war. In addition to the import statistics of purchasing countries, the later studies will show also the exports from the principal manufacturing nations, in order to give a general view of the markets that are supplied by each of our principal competitors. The export tables will indicate the markets that are available to the product in question, while the import tables will show the competition likely to be encountered in those markets. Compilations are in progress for leather boots and shoes, cement, and paper and paper products. The following additional classes of commodities will be taken up: Automobiles, bicycles, and motorcycles; vehicles other than motor; agricultural implements; chemicals; paints and varnishes; soap; leather goods, except boots and shoes; rubber goods; typewriters and adding machines.

Additional work was done on the statistical tables showing the imports and exports of cotton manufactures in the principal countries

importing or exporting these goods. This study covers the five years prior to the war and gives the statistics according to the import or export classification used by the various countries. The revision and conversion of the material was practically completed by the end of the year, and arrangements had been made to have the interpretative text written by a former member of the staff of the Bureau, who has made personal studies of the markets for American cotton goods in foreign countries.

The foreign markets for many of the commodities mentioned above have been described in detail in the monographs written by the special agents of the Bureau. These statistical studies will supplement the data given in the monographs, and the two series of publications will enable the American manufacturer to obtain both detailed statistical data on these products and specific information on the local conditions in the various markets.

COMPILED STATISTICS FOR PARTICULAR COMMODITIES.

The division has also compiled a number of short statistical statements on the trade in particular commodities. Whenever one of these compilations of any general importance is made a notice is inserted in Commerce Reports so that the material may be available to all persons interested in the commodity. On account of the limited force and the pressure of the regular work, it is impracticable to make lengthy compilations of foreign statistics for individuals, but the division is always glad to direct inquirers to the sources of information and to give such incidental assistance as may be necessary in the interpretation of the foreign schedules.

Considerable assistance has been rendered from time to time to the war organizations by furnishing statistical compilations or by compiling lists of references to articles that have appeared in Commerce Reports and other publications. In the case of lengthy compilations the detailed work has generally been done by clerks of the organizations desiring the data, as the small force in the division of research could not handle the work to advantage. The research assistants of the other organizations have been directed to the sources of information and have been given such assistance as was necessary to enable them to interpret the schedules and statistical tables.

Interest in foreign trade and the economic conditions in foreign countries has increased to a marked degree since the beginning of the war in Europe and especially since the entry of the United States into the conflict. The Bureau has frequent calls for information of this character from Government offices that are dealing with international questions and from exporters and manufacturers who are looking into the possibilities of trade extension after the war. In order to meet the demand, certain members of the staff are devoting time to the preparation of brief articles on the industry and trade of regions whose economic development is not so well known in the United States. Articles on the Ukraina and the Baltic Provinces of Russia have been published in Commerce Reports, and articles on Roumania and the German colonies in East Africa are well in hand. Other countries and colonies will be taken up as rapidly as possible.

STUDY OF FOREIGN STATISTICAL SCHEDULES.

The increasing use of foreign statistics, the shortage of assistants with a thorough knowledge of foreign languages, and the fact that the Bureau does not have a force large enough to publish foreign statistics in English render it highly desirable that translations of the import and export schedules of the principal foreign countries be prepared. It is therefore planned to make close translations of these schedules; many of the terms are used in so technical a sense that they are not clear even to a person who has a fair knowledge of the language but who is not familiar with the statistical reports or the special commodities enumerated. The foreign and English texts will be printed side by side so that the searcher may readily find the meaning of the term used, even if the schedule numbers are changed. An adequate index in English will save much time in locating the statistical information desired. A beginning has been made on the translation of the German, French, and Italian schedules, and the work will be pushed to completion as rapidly as possible. The publication of these translations will not only aid the translators of the division but will also be of material assistance to compilers in other cities where foreign statistical reports are available.

DIVISION OF STATISTICS.

Notwithstanding the many difficulties under which foreign trade has been carried on since this country entered the war, perhaps even because of the difficulties, business men have been making more inquiries for commercial statistics than ever. Many such inquiries during the year were from firms not heretofore engaged in foreign trade, studying the field with the expectation of entering foreign markets after the war. Export statistics for South America and the Far East and figures of imports prior to the war from France, Germany, and England were most sought. Requests for statistics of imports of soya beans, peanuts, copra, and other oil-bearing materials were unusually numerous, largely from southern oil mills who sought to obtain oilseeds for the purpose of keeping the mills running between the cottonseed and peanut seasons. These raw-material statistics were in increasing demand as the shipping restrictions increased, the sources of foreign supplies becoming of really vital importance.

The Monthly Summary of Foreign Commerce, as well as the annual report on Commerce and Navigation, were at times considerably delayed, owing to the great volume of printing to be handled for the special war boards, which was given precedence over the regular printing. As the war boards required the figures, original printing was speeded up at their urgent request on the Public Printer. The tables in the Monthly Summary were rearranged and an index of articles added. It is expected to add such an index to the separate issues of the annual five-year tables, Nos. 3 and 5, imports and domestic exports by articles and countries, which will increase their value for reference purposes. The list of principal countries shown in the import and export tables of the Monthly Summary of Foreign Commerce was revised and enlarged to correspond with changes since

the war. The publication "Trade of the United States with the World," showing imports and exports by articles with each country, was brought up to date for the fiscal years 1916 and 1917 and issued in two bulletins as Miscellaneous Series No. 63, part 1 showing imports and part 2 exports. This publication is in great demand by exporters and dealers studying possibilities for extending foreign trade. Henceforth this will be issued annually, instead of every two years, as in the past.

MECHANICAL TABULATION OF STATISTICS.

The Bureau of Customs Statistics at New York, established by the Treasury Department for the purpose of handling for this Department the mechanical tabulation of foreign-trade statistics for all ports of the United States, has instituted various improvements during the year and the export reports can now be furnished this office for compilation, revision, and publication more promptly than under the former system of direct reports from each collector of customs. The cards punched each day are compared with the data on the original shipper's declaration, which has resulted in a marked improvement in the accuracy of the reports. The requirement of the export embargo act that all shipments to foreign countries have to be licensed by the War Trade Board has had a decided tendency to make shippers more careful in preparing export declarations and has resulted in more accurate statistics.

Mechanical tabulation through the fiscal year under review covered only exports, but since the beginning of the present fiscal year (1919) extends to all import, warehouse, and noncontiguous-territory reports. A uniform standard entry blank has been established, an additional copy of which is to be forwarded from each customs port of entry to the Bureau of Customs Statistics at New York, the cards to be punched direct from these entries. Separate documents for tabulating import and export statistics are thus available for statistical use without reference to the documents used by the collectors in the collection of tariff duties.

REPORTS FROM COLLECTORS OF CUSTOMS SIMPLIFIED.

Collectors of customs have been furnishing to this office monthly reports of imports and exports of gold and silver, and in addition weekly reports of such transactions to the Federal Reserve Board of the Treasury Department. The monthly reports to this office have been discontinued and arrangements made with the Federal Reserve Board to change their reports to cover 10-day periods, the last report for the month to include from the twenty-first to the last day of the month. Totals by countries and customs districts for 10-day periods will be compiled for the use of this office in publishing the monthly and annual gold and silver statistics.

Reports from collectors of customs to this Bureau will be required only for drawback transactions, vessels entered and cleared in the foreign trade, and bunker coal and oil furnished to these vessels. All other statistical reports will be directed to the Bureau of Customs Statistics at New York, established for this purpose.

REVISION OF IMPORT CLASSIFICATION.

A new schedule governing the classification of imports became effective on July 1, 1918. This new schedule is a combination of the former Schedule A for the monthly import reports and Schedule E for the quarterly reports of imports entered for consumption. Instead of two separate classification numbers it will only be necessary to indicate for each item on the import entries one class number, running at the highest up to five figures, the whole number applying to the quarterly imports for consumption report, while for the classification of the monthly imports the two right-hand figures are to be ignored. This method will simplify the mechanical tabulation of imports.

The new classification shows considerable more detail than the former Schedule E, as practically every item mentioned in the tariff law is separately classified. Many commodities covered in the tariff law in one paragraph are further subdivided in the statistical classification, especially free goods, such as agricultural implements, raw fibers, fresh and cured fish and meats, raw hides and skins, fur skins, leather, and others. This detailed classification was provided for the special benefit of the United States Tariff Commission in its work of collecting information regarding imported commodities for the use of Congress in tariff legislation.

It is hoped in the coming year to introduce a more complete revision of the present classifications, exports as well as imports.

PROPOSED LEGISLATION.

It has been recommended that Congress authorize the change of issuing the annual report on the foreign Commerce and Navigation of the United States to the close of the calendar year instead of the fiscal year ending with June 30, as is now required by a law originally passed in 1820 and reenacted in 1866. The business year of commercial firms as well as many Government bureaus and most foreign countries is the calendar year, and statistics for this period are in greater demand than for our arbitrary fiscal year. Shortly after the close of the fiscal year a bill to bring about this change was introduced in Congress.

Congress has not provided for resumption of the service of collecting and publishing statistics of internal commerce, which was stopped in 1912 for want of an appropriation. There is a continual demand for statistics of commercial movements on rivers, canals, and the Great Lakes, coastwise shipments between Gulf and Atlantic ports, and other phases of domestic trade for which no complete or official statistics are available. The Bureau continues to receive such requests and feels the need for this work.

Our shipments to foreign countries by parcel post are rapidly increasing and the total value of this business probably amounts to several million dollars annually. There is no law requiring returns of goods sent by mail and they are therefore not included in the export statistics. Plans are under discussion to remedy this condition.

STATISTICAL WORK IN CONNECTION WITH THE WAR.

After the entrance of this country into the war the calls for foreign-trade statistics from the various special boards created to handle particular war activities so increased as to interfere seriously with the

regular work of preparing tables for publication. The War Trade Board, originally organized in this Bureau as the Exports Administrative Board, was the first to make extended use of statistics in connection with its work of licensing imports and exports. The Food Administration was no less active in its use of statistics for guidance in conservation and stimulating production of foodstuffs, and the Bureau of Markets of the Department of Agriculture called for statistics of imports and exports of agricultural raw products. The Shipping Board desired data on available vessel tonnage, vessel movements, and port facilities, also import and export statistics by articles, countries, and customs districts, by months of the current as well as past years, with monthly, semiannual, and annual averages, compiled in every conceivable form and manner. The Council of National Defense and its various subcommittees, the Textile Alliance, Tanners' Council, and other organizations in charge of special industries, the Fuel Administration, and later on the War Industries Board made extensive use of foreign-trade statistics. In fact, every Government office handling problems connected with the war called on the division for statistics.

Naturally enough, the condensed figures as published did not always meet these requirements, and in the majority of cases it was necessary to go back to the detailed monthly records on file in the division. It soon developed that it would be a hopeless task for the limited number of statistical clerks available for special work to undertake to compile all of these statistics, and arrangements were therefore made to furnish desk room and place the records at the disposal of clerks detailed from the War Trade and Shipping Boards, the Food Administration, and other offices as the need might arise. This arrangement has worked admirably, and it has been possible for these offices to keep their figures up to date with the reports for the latest available period, as a rearrangement of our files into smaller units made it possible for a number of clerks to work on the latest reports at the same time. On an average, about 10 clerks from both the War Trade and Shipping Boards have been constantly working in the division, with occasional details from the Food Administration, Bureau of Markets, and other offices. Besides the many statements actually compiled by the clerks of this division, too numerous to mention by title, a large part of our time has been taken up in assisting and directing the clerks detailed from these offices.

IMPORT AND EXPORT REPORTS FOR 10-DAY PERIODS.

Early in the year the special war boards suggested that the monthly statistics, available within a month to six weeks after the close of period to which they pertain, were not sufficiently up-to-date to enable them to keep in close touch with the problems studied. Plans were immediately perfected to furnish each month three 10-day period reports, covering from the 1st to the 10th, 11th to 20th, and 21st to last day of each month, respectively. Beginning with November, such 10-day period reports of imports of hides and skins, leather, and tanning materials into 13 principal customs districts were furnished to the Tanners' Council of the United States. The War Trade and Shipping Boards, the Food Administration, and the Bureau of Markets were furnished with copies of reports of all exports during

10-day periods from each customs district, by articles and countries, each of these offices compiling from these reports such figures as pertained to its work.

This plan proved not entirely satisfactory, and a conference of representatives of the Treasury Department, the War Trade and Shipping Boards, Food Administration, and this Bureau was called in the latter part of January, 1918, for the purpose of devising plans to improve the situation. Dean Edwin F. Gay, of Harvard, as director of the division of planning and statistics of the Shipping Board, presented the requirements of the various war boards for prompter statistical service. After a full discussion of the methods in use, and additional facilities needed for the improvement of the statistical service, the following recommendations were made:

That the Bureau of Customs Statistics of the Treasury Department at New York be equipped to compile consolidated reports of imports into and exports from all ports of the United States for 10-day periods; reports for each period to include import entries and export declarations received at New York up to the 6th, 16th, and 26th of each month; such reports to be mailed to the Bureau of Foreign and Domestic Commerce at Washington by the 13th, 23d, and 3d of the month, and that Bureau to furnish to the various war offices the statistics required within 4 days after the receipt of the 10-day period reports; such reports for exports to commence with February, and for imports as soon as a standard form of entry, which would greatly facilitate the compiling of import statistics, should be required by the Treasury Department. It was also recommended that where no unit of quantity is required by the statistical classification of the Department of Commerce the net weight of all commodities be shown in import entries and export declarations, and that the classification be adjusted to meet the needs of the war boards. A photostat copy of the import and export tables published in the Monthly Summary is to be furnished each month to the war boards in advance of publication.

These recommendations were approved by the Secretaries of the Treasury and Commerce, and in order to equip the Bureau to carry them into effect the sum of \$25,000 was allotted by the President from the special fund for National Security and Defense for the remainder of the fiscal year. The 10-day reports have been furnished for exports since February and for imports since April promptly within the stipulated time. These statistics for 10-day periods are for the confidential use of the war boards and not for publication. The President renewed and enlarged the special funds for this purpose for the fiscal year 1919.

REVISION OF EXPORT CLASSIFICATION.

In order to meet the needs of the war boards as well as of commercial interests for more detailed statistics of exports for commodities in which the trade has largely increased since the war, but which are hidden in "all other" classes, suggestions from boards of trade, chambers of commerce, and private firms for new classes were invited through notices published in Commerce Reports, trade papers, and the daily press. The War Trade and Shipping Boards and the

Food Administration also assisted in obtaining suggestions for a more detailed classification through their trade experts and special committees. A generous response followed the invitations extended through the press and a large number of suggestions were received. All were carefully considered, sometimes after consultation with the collectors of customs at New York and other principal ports, and such as were deemed practicable were incorporated in the new classification. The revision resulted in the addition of more than 600 new articles or groups to the existing classification of 685 items.

While primary consideration was given to the needs of the war boards, the object of making the classification of the greatest possible value to commercial interests in trade promotion after the war was constantly kept in view. As the work developed need of constructing an entirely new classification, based on a decimal group system of commodities, became apparent and was undertaken by the Department of Commerce in cooperation with the War Trade Board, the new classification to be for the use of both offices, superseding the present schedules.

In view of the fact that the end of the fiscal year was approaching and that it would not be possible to construct such a new classification by the beginning of the new fiscal year, it was necessary to continue the old export classification for the present, but a reclassification along the lines suggested from the material available in the Bureau and being collected is under way. No efforts will be spared to make this new classification of the greatest possible value to the war boards, should the war continue, and to commercial firms, the press, and the general public.

TRADE-INFORMATION DIVISION.

Requests by mail for miscellaneous commercial information and for specific data on foreign markets (except those relating to Latin America and the Far East) are handled in the division of trade information, which was known as the trade-information section prior to July 1, 1918.

Considering the effect the war has had upon our export trade, the results of the normal trade-promotion work of the division during the year are very encouraging.

The correspondence of the division has given evidence during all the year of decided and continued interest in foreign markets on the part of American manufacturers and exporters. Those houses whose regular export trade has been curtailed as a result of necessary war-time regulations, as well as firms new to foreign trade, have shown a marked tendency to keep their interest in export trade actively alive and to make all possible preparation for the unusual opportunities that will be open to American industry after hostilities cease. The continued interest in foreign trade on the part of American manufacturers and exporters is emphasized by the number of requests for the names and addresses reserved from the "Foreign Trade Opportunities" printed in the Commerce Reports. The Washington office and its seven district offices received and complied with approximately 135,000 individual requests for these reserved addresses, which comprise the names of foreign firms who have expressed an interest in American goods.

Including the miscellaneous stenographic work done for other divisions of the Bureau (which was not nearly so extensive as during the preceding fiscal year owing to a policy of providing the different divisions with their own stenographic assistance), approximately 50,000 outgoing communications were prepared during the year.

REGULAR TRADE INQUIRIES.

Requests for information concerning foreign markets covered hundreds of commodities. The following are a few of the articles selected at random from our files about which manufacturers and exporters expressed a desire to receive specific data: Stoves, automobiles, tractors, leather belting, pumping machinery, tobacco, motion pictures, dyestuffs, mining equipment, phosphate rock, table waters, cotton goods, jewelry, milling machinery, lumber, electrical apparatus, bottling machinery, paints and varnishes, proprietary medicines, boots and shoes, office equipment, and so on.

The number and class of letters of appreciation received indicate that the division's services are appreciated and that it renders practical and efficient assistance through its correspondence. The following are quoted as typical of the class of acknowledgments received:

From the editor of a periodical in Washington, D. C.:

Allow me to thank you most sincerely for your reply to my note. This information is very complete and is very satisfactory indeed.

From the export manager of one of the largest manufacturers in the country:

Thanks very much for your exhaustive letter of explanation with reference to the paint and varnish situation in foreign markets, as contained in your letter of October 20. The information you have given us is indeed valuable.

From a firm in San Francisco:

We can not place on file your valued favor of October 30 without first expressing to you our keen appreciation of the interest which you have shown in response to our inquiry of October 13. Service such as you are giving can not fail to prove most helpful to American exporters and manufacturers.

From a manufacturer of toys (this is an industry that has developed rapidly in this country since the war started):

This is to thank you for yours of the 13th. We are under the impression that very few manufacturers in this country realize the opportunities offered by your department. It is more or less inspiring to find so much cooperation by our Government.

In connection with its trade-promotion work the Bureau maintains very close cooperative relations with the principal commercial organizations throughout the country. The following commendatory letters received from three representative business associations indicate that our service in this respect is of definite value:

Your reply of December 6 to my request for something about the foreign-trade service of your department illustrates perfectly the amazing advance which the Federal departments have made since I first tried to use them nearly 20 years ago. It sickens the individualist to reflect that it is Government rather than nongovernmental mechanism which has built up the situation underlying such a letter as yours; but since Government is doing the work there is no getting away from this—that it is of a high order on any standard, public or private.

I have been very slow in replying to your splendid letter of September 7, in which you give me so definite an answer to my request for information concerning foreign markets. But as a matter of fact, I only had an opportunity to take up this matter seriously the other day, and I am just beginning to realize what a really remarkable service it is that you are qualified to give.

When under recent date I attempted to anticipate the arrival of material which you had stated was en route, by thanking you in advance for same, I should have used superlatives in thanking you.

In addition to the foreign-trade service, this division receives and complies with many requests for the names of American manufacturers, exporters, and importers in various lines. Our file of directories and card indexes covering data of this kind is being constantly developed. We now have a file of about 100 trade directories covering practically all industries for the United States and other principal countries. A special card index of American importers arranged by articles, compiled in this division during the year, and probably one of the most detailed indexes of this character available, has proved of much practical use not only in answering correspondence but to other divisions of the Bureau as well.

A plan was worked out and put into operation whereby, in co-operation with the distribution section, the Bureau's "Exporters' Index" (a card record of approximately 30,000 American firms interested in export trade) might be used efficiently in bringing to the attention of American houses inquiries about American goods received direct from correspondents in foreign countries.

A revised edition of the correspondence manual was prepared to serve as a guide to all employees having anything to do with the preparation of mail. It is the Bureau's "style book" for its own employees.

WAR WORK.

This Bureau's elaborate files of information covering commerce and industry in foreign countries and its established organization for obtaining special data and keeping up to date the material on hand placed it in an especially favorable position to render definite assistance to the newly organized war offices in Washington and elsewhere. This division had supervision over the principal files of data of this kind up to December 31, 1917.

The trade information division's participation in war work was not, however, confined to furnishing data on foreign countries. The division's special file of directories and lists of names concerning various industries and the expert knowledge of its personnel again enabled it to be of assistance to many of the official organizations devoted to war work.

Another special feature of service that it seems proper to mention under the head of the "war work" of this division is the assistance rendered to American firms and individuals who desired to locate domestic sources of merchandise formerly imported from one of the Central Powers. Our special facilities for keeping in touch with new industries, coupled with a wide and varied knowledge of unofficial sources of such facts, has placed the Bureau in a position to be of considerable assistance to correspondents interested in this class of information. Needles, asbestos packing, harmonicas, optical glass, fabrics suitable for typewriter ribbons, dyestuffs, galalith, and almonds were some of the articles included in these inquiries.

The work of encouraging the use of fiber containers as substitutes for containers made of tin, and assisting the manufacturers of these containers to get in touch with consumers, and vice versa, was continued. The correspondence and detail connected with this work was assigned to the trade information division.

EDITORIAL DIVISION.

Owing to the constantly increasing restrictions on foreign trade there was not the opportunity for the direct promotion of trade through publicity that is carried on in normal times, and this is reflected in the publications of the Bureau. The number of foreign-trade opportunities published in Commerce Reports, aside from those resulting from the Lyon Fair, was 2,324 in 1917 as compared with 2,917 in 1916 and 4,300 in 1915. The confidential circulars numbered 16 in 1917, while in the preceding year 57 were distributed. These two items reveal clearly the extent to which direct trade-promotion work has been restricted.

Another factor in the situation is the additional work imposed upon the Consular Service by the enforcement of the trading-with-the-enemy law and the export-license regulations, and by other duties incident to the war. The necessity of devoting much of their time and energy to these duties has made it impossible for the consular officers to give their usual attention to the preparation of commercial reports; but notwithstanding this they have rendered efficient service, through the Bureau's publications, in keeping the business interests of the country informed as to changing conditions abroad and in compiling facts as to trade conditions, so that when the war is ended the exporters and manufacturers will have at hand the information that they must consider in mapping out a program for foreign trade activities.

The reports of the commercial attachés and of the Bureau's special agents were issued as promptly as they could be handled by the editorial division. In all of these emphasis was laid upon the changes in the normal trade channels due to the war, and upon the conditions that must be met for successful after-the-war competition so far as they can be foretold. Among them was a series of reports on wearing apparel in South America, which were prepared under the supervision of the commercial attachés. To supplement this series a report on wearing apparel in Chile was prepared by a special agent of the Bureau engaged in an investigation of the South American textile markets.

By the end of the year the editorial division had prepared for printing over 50 of the Spanish-English specifications for industrial materials. This involved a large amount of painstaking work, as the value of the publication depends to a great degree upon the accurate reproduction of the text and the proper arrangement of the material and illustrations. The first of this series, "Standard Specifications and Tests for Portland Cement," was issued about the close of the fiscal year.

The following table summarizes the publications of the Bureau during the year, all of which, excepting those on foreign tariffs and the purely statistical publications, were handled by the editorial division.

PUBLICATIONS ISSUED DURING THE FISCAL YEAR ENDED JUNE 30, 1918.

Publications.	1916		1917		1918	
	Number.	Pages.	Number.	Pages.	Number.	Pages.
Commerce Reports.....	307	5,328	306	4,896	306	4,912
Supplements to Commerce Reports.....	129	1,864	107	1,735	110	1,608
Index to Commerce Reports and Supplements..	5	264	5	217	5	218
Special Consular Series.....	2	196	1	12	5	264
Special Agents Series.....	18	1,636	27	2,344	26	2,609
Miscellaneous Series.....	13	2,573	24	2,782	11	1,112
Monthly Summary of Foreign Commerce.....	12	1,045	12	1,104	12	1,164
Commerce and Navigation.....	1	974	1	960	1	956
Statistical Abstract.....	1	749	1	773	1	804
Other statistical publications.....	29	320	29	412	26	402
Tariff Series.....	4	159	3	66	3	159
Foreign Tariff Notes.....	4	179	4	192	3	192
Confidential Bulletins.....	1	7	1	42	1	78
Annual Report of Chief of Bureau.....	1	75	1	97	1	77
Catalogue of Bureau's Publications.....	1	47	1	4	1	49
Monthly Letter.....	13	289	12	192	12	214
Total.....	541	15,705	535	15,788	522	14,813

* Supplement to catalogue.

For some years the Bureau has made use of unpublished consular reports by loaning them to commercial organizations and individual firms, the arrangement for such loans usually being effected through the district and cooperative offices. To facilitate this work and to provide precise information as to the manuscript reports available and the field they cover, the editorial division prepared a synopsis of each of the series of reports and bound the reports up in such form that they can be easily consulted and conveniently handled. Copies of the synopsis were placed in the hands of all Bureau employees engaged in research work or in handling trade inquiries, so that the best use may be made of the unpublished material.

Publication of the annual reports of the consular officers in belligerent countries was resumed early in the fall of 1917 and a comparatively large number appeared before the close of that year. These reports review the industrial, commercial, and financial conditions in the respective districts, and are issued as supplements to Commerce Reports.

Steps were taken to organize the card trade directory that is designed to supplant the published directories heretofore issued by the Bureau. Owing largely to the regulations governing trading with the enemy it is impossible during the war to furnish printed directories of foreign firms, and in lieu of such directories the Bureau has extended this distribution of trade lists compiled by the consular officers and is engaged in the preparation of a card directory giving more detailed information with regard to the principal foreign firms.

The Bureau's catalogue of publications was completely revised during the year and brought up to date. This catalogue contains a concise description of each of the Bureau's publications and is invaluable to those who make use of the Bureau's published material.

PUBLICATIONS ISSUED.

The following list gives the titles of the new publications handled during the year:

SPECIAL AGENTS SERIES.

No. 146. Markets for agricultural implements and machinery in South Africa, by Juan Homs; 231 pages. Price, 20 cents.

No. 147. Electrical goods in New Zealand, by R. A. Lundquist; 47 pages. Price, 5 cents.

No. 148. South American markets for dried fruits, by Walter Fischer; 35 pages. Price, 5 cents.

No. 149. Cotton goods in British India: Part IV, Bombay Presidency, by Ralph M. Odell; 132 pages. Price, 15 cents.

No. 150. Commercial laws of Switzerland, by Archibald J. Wolfe, supplemented and revised by Robert P. Shick and Phanor James Eder; 52 pages. Price, 10 cents.

No. 151. Shoe and leather trade in New Zealand, by C. E. Bosworth; 31 pages. Price, 5 cents.

No. 152. Market for boots and shoes in Peru, by Herman G. Brock; 89 pages. Price, 15 cents.

No. 153. Chilean market for paper, paper products, and printing machinery, by Robert S. Barrett; 72 pages. Price, 15 cents.

No. 154. Electrical goods in Ecuador and Peru, by Philip S. Smith; 51 pages. Price, 10 cents.

No. 155. Electrical goods in Australia, by R. A. Lundquist; 64 pages. Price, 15 cents.

No. 156. Railway materials, equipment, and supplies in Australia and New Zealand, by Frank Rhea; 164 pages. Price, 25 cents.

No. 157. Cotton goods in British India: Part V, Summary of trade: Part VI, Cotton manufacturing; by Ralph Odell; 57 pages. Price, 10 cents.

No. 158. Textile markets of Bolivia, Ecuador, and Peru, by W. A. Tucker; 106 pages. Price, 15 cents.

No. 159. Shoe and leather trade in Australia, by C. E. Bosworth; 39 pages. Price, 5 cents.

No. 160. Construction materials and machinery in Colombia, by W. W. Ewing; 75 pages. Price, 15 cents.

No. 161. Shoe and leather trade in the Philippine Islands, by C. E. Bosworth; 23 pages. Price, 5 cents.

No. 162. Colombian markets for American furniture, by Harold E. Everley; 34 pages. Price, 5 cents.

No. 163. Paper, paper products, and printing machinery in Argentina, Uruguay, and Paraguay, by Robert S. Barrett; 166 pages. Price, 20 cents.

No. 164. Textile markets of Chile, by W. A. Tucker; 52 pages. Price, 10 cents.

No. 165. Tanning materials in Latin America, by Thomas H. Norton; 32 pages. Price, 5 cents.

No. 166. Agricultural implements and machinery in Australia and New Zealand, by Juan Homs; 195 pages. Price, 25 cents.

No. 167. Electrical goods in Bolivia and Chile, by Philip S. Smith; 94 pages. Price, 20 cents.

No. 168. Wearing apparel in Chile, by W. A. Tucker; 75 pages. Price, 10 cents.

No. 169. Investments in Latin America and British West Indies, by F. M. Halsey; 544 pages. Price, 50 cents.

No. 170. Motor vehicles in Japan, China, and Hawaii, by T. O. Jones; 75 pages. Price, 15 cents.

No. 171. Brazilian markets for paper, paper products, and printing machinery, by Robert S. Barrett; 74 pages. Price, 10 cents.

SPECIAL CONSULAR REPORTS.

No. 76. Turkish markets for American hardware, by G. B. Ravndal, formerly consul general at Constantinople; 48 pages. Price, 10 cents.

No. 78. East African markets for hardware and agricultural implements, by Henry P. Starrett, consul at Mombasa; 27 pages. Price, 5 cents.

REPORT OF CHIEF, BUREAU FOREIGN AND DOMESTIC COMMERCE. 237

No. 79. Olive growing in Spain, by Wilbur T. Gracey, consul at Seville; 84 pages. Price, 5 cents.

No. 80. Foreign markets for cotton linters, batting, and waste; 84 pages. Price, 10 cents.

No. 81. Abyssinia: Present commercial status of the country, with special reference to the possibilities for American trade, by Addison E. Southard, consul at Aden; 71 pages. Price, 5 cents.

INDUSTRIAL STANDARDS.

No. 1. Standard specifications and tests for Portland cement; 47 pages. Price, 10 cents.

MISCELLANEOUS SERIES.

No. 62. Argentine market for motor vehicles; 27 pages. Price, 5 cents.

No. 63. Trade of United States with the world, 1916-17. Part 1, Imports; Part 2, Exports; 317 pages. Price, part 1, 10 cents; part 2, 20 cents.

No. 64. Wholesale prices of leading articles in the United States markets; 14 pages. Price, 5 cents.

No. 65. German trade and the war; 236 pages. Price, 25 cents.

No. 66. Furniture imports of foreign countries; 31 pages. Price, 5 cents.

No. 67. Export lumber trade of the United States; 117 pages. Price, 20 cents.

No. 68. Wearing apparel in Argentina; 158 pages. Price, 20 cents.

No. 69. Wearing apparel in Bolivia; 84 pages. Price, 10 cents.

No. 70. Conduct of business with China; 50 pages.

No. 71. Wearing apparel in Brazil; 64 pages. Price, 10 cents.

No. 72. Consumption estimates, production, imports, and exports; 14 pages. Price, 5 cents.

The editorial division further improved its facilities for handling its work by installing an index of the foreign firms for whom trade-opportunity notices have been published within the last two years. This index has proved especially helpful in answering inquiries that the Bureau receives with regard to the references given by foreign firms.

The system of indexing daily Commerce Reports and other publications was further improved and correlated with the system of filing clippings from Commerce Reports, both in the Bureau and the district and cooperative offices. By making the classifications and filing systems uniform the work of clerks engaged in consulting the Bureau's material is considerably reduced.

CHIEF CLERK'S OFFICE.

ACCOUNTS SECTION.

The work of the accounts section consists chiefly of verifying accounts presented for payment, auditing the accounts of special disbursing agents, maintaining a record of the funds disbursed from the various appropriations under the direction of the Bureau, preparing statements as to the costs of the various investigations, instructing the field employees with regard to the method of rendering their accounts, conducting the correspondence with regard to all accounting matters, and preparing data for the annual appropriation budgets.

There were passed for payment during the year 2,001 vouchers covering salary and traveling expenses of employees in the field, purchase of supplies and equipment, and miscellaneous services (not including vouchers covering purchases made by the division of supplies out of the contingent appropriation), as against 1,825 vouchers

during the year ended June 30, 1917, 1,876 vouchers during the year ended June 30, 1916, and 1,700 vouchers during the year ended June 30, 1915. There were 3,477 letters written during the current year as compared with 4,600 during 1917, 3,950 during 1916, and 3,700 during 1915. In addition, there were issued 175 travel orders, as well as numerous statements showing the conditions of the various appropriations, expenditures made for the several investigations, and other fiscal matters. While the work of the section was increased quite a little, owing to the increased appropriations, there was no increase in the number of employees assigned to the section. Owing to war conditions and resignations, it has been impossible to maintain a complete force in the section.

There was appropriated for the fiscal year 1918 the sum of \$109,000 for the commercial attaché service, \$125,000 for the promotion of commerce, \$100,000 for the promotion of commerce with South and Central America, in addition to \$154,120 for the salaries of statutory positions in the Bureau and allotments of \$5,500 for contingent expenses and \$118,500 for printing and binding. In addition to the above amounts the President allotted to the Bureau the sum of \$125,550 from the national security and defense funds for the purpose of carrying on certain war activities for which the Bureau had no available funds, making a total of \$637,670 for the year, as against \$544,530 for the preceding year. Out of these appropriations there were employed in the field during the year 104 persons, including the commercial attachés, their clerks, and the employees in the district offices of the Bureau, a great number of whom, however, were employed for short periods only. Forty-nine of these employees disbursed funds as special disbursing agents, as against 45 for the fiscal year ended June 30, 1917, and 28 for the fiscal year ended June 30, 1916. All commercial attachés, special agents, trade commissioners, and commercial agents who are sent out of the United States to make special investigations or a study of conditions abroad are appointed special disbursing agents, and must give bond satisfactory to the Department.

APPOINTMENTS WORK.

The following examinations were held by the Bureau during the fiscal year ended June 30, 1918:

- Commercial agent and assistant commercial agent in the district-office service.
- Special agent to investigate general commercial and economic conditions in (1) Mexico, (2) Colombia and Venezuela, and (3) Bolivia and Paraguay.
- Commercial attaché.
- Special agent to investigate South American markets for textiles.
- Special agent to investigate South American markets for paints and varnishes.
- Special agent to investigate South American markets for drugs and chemicals.
- Special agent to investigate markets for industrial machinery in the Far East.
- Special agent to investigate markets for construction materials in the Far East.

One hundred and eighty-six persons took the commercial agent examination; 97 persons, the special agent examination to investigate general commercial and economic conditions; 157, the examination for commercial attaché; 16, South American markets for paints and varnish; 10, South American markets for textiles; 1, South American

markets for drugs and chemicals; 38, markets for construction materials in Far East; 41, markets for industrial machinery in Far East.

After applicants pass the written examinations they are invited to come to Washington to appear before the oral examining board. This board consists of the Chief and Assistant Chiefs of Bureau, the Chief of the Appointments Division of the Department, the Chief Examiner of the United States Civil Service Commission or his representative, and a number of the division chiefs within the Bureau. For the commercial attaché examinations the Assistant Secretary of State is notified and invited either to attend the oral examinations himself or send a representative. These examinations afford an opportunity to decide upon the personal fitness of the candidates for the particular positions.

Whenever written examinations are to be held applicants are attracted by announcements in the daily press, the trade papers interested in the industrial and commercial lines to be investigated, through commercial organizations, and through all the channels of publicity that are available to the United States Civil Service Commission. With all these facilities, however, it is becoming more and more difficult to find suitable trained men to carry on the Bureau's work.

DISTRIBUTION SECTION.

The distribution section distributes the literature published by the Bureau, such as monographs, confidential circulars and bulletins, press statements, etc., and maintains the various mailing lists, consisting of commercial organizations, trade associations and trade journals, banks with foreign departments, steamship companies, export commission houses, and foreign freight agents and forwarders. To these lists are addressed printed matter relating to foreign-trade possibilities and notices of all new publications issued by the Bureau, as well as other matter of specific interest.

The Exporters' Index is also maintained in this section and consists of between 25,000 and 30,000 names of American concerns interested in export trade. This list is for official use only. Something like 470,000 notifications of new publications were sent to firms on the list during the year, as well as a number of confidential circulars announcing opportunities in regard to foreign trade. Subjects of specific interest appearing in the daily Commerce Reports are marked and copies sent to firms on the Exporters' Index.

During the year the lists of foreign importers forwarded by consular officers, special agents, and commercial attachés were increased by approximately 1,000. There were approximately 3,500 individual requests for these lists during the year, association requests often necessitating the sending out of several hundred lists. The names appearing on these lists are checked against the trading-with-the-enemy list before being sent out, and approximately 26,000 lists were thus checked during the year. All users are warned to consult the Bureau of War Trade Intelligence.

Possibly three-fourths of the work of this section during the year related to Latin America. A mailing list for the Latin American Circulars is maintained in this section and approximately 200 copies of each circular are distributed.

The following table shows the number of publications and circulars distributed by the Bureau during the fiscal years 1916, 1917, and 1918:

PUBLICATIONS DISTRIBUTED DURING THE FISCAL YEARS ENDED JUNE 30, 1916, 1917, AND 1918.

Publications.	1916	1917	1918
Monographs:			
Special agents series.....	23	22	24
Special consular reports.....	4	1	4
Miscellaneous series.....	15	16	10
Foreign tariff series.....	4	4	3
Foreign tariff notes.....	4	4	4
Confidential bulletins.....	1	1	1
Statistical publications.....	55	55	57
Confidential circulars.....	173	51	16
Press letters.....	263	95	122
Selling letters.....	37	45	42
Miscellaneous circulars.....	20	11	.....
Annual report of Chief of Bureau.....	1	1	1

APPROPRIATIONS AND ESTIMATES.

The table below shows the appropriations that were available for the fiscal year ended June 30, 1918, those available for the fiscal year ending June 30, 1919, and the estimates that are to be submitted for the fiscal year ending June 30, 1920. It gives the number of persons employed and the amount of money expended in each branch of the work. It will be seen that an appropriation of \$1,365,470 is asked for the fiscal year 1920, this being an increase of \$811,350 over the year 1919.

APPROPRIATIONS FOR THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS ENDING JUNE 30, 1918 AND 1919, AND ESTIMATES FOR THE YEAR ENDING JUNE 30, 1920.

Appropriations and classes of work.	1918		1919		1920	
	Employ-ees.	Amount.	Employ-ees.	Amount.	Employ-ees.	Amount.
Statutory appropriation:						
Administration.....	5	\$16,350	6	\$18,150	8	\$34,500
Accounts, records, and files.....	27	28,980	22	22,820	29	33,520
Collating tariffs.....	3	4,200	3	4,400	9	13,250
Compiling statistics.....	30	41,280	28	39,340	42	60,990
Distributing information.....	5	5,100	6	6,900	7	9,300
Division of commercial attachés.....	2	2,200	2	2,700	5	8,750
Division of district offices.....	2	3,200	1	1,000	5	8,750
Division of field investigators.....	2	2,800	1	1,400	5	8,750
Editorial work.....	15	21,800	11	16,400	19	29,650
Latin American division.....	3	4,400	8	8,400	16	23,980
Research and translation.....	5	8,600	8	12,910	33	64,800
Trade information.....	14	15,200	15	17,800	16	21,550
Far Eastern division.....			2	1,900	5	8,750
Total.....	113	154,120	113	154,120	190	327,470
Promoting commerce:						
Office staff.....					(a)	(a)
Field investigators.....	25	75,000	20	70,000	28	122,976
Miscellaneous.....		5,000		5,520		20,744
Maintenance of district offices—						
Salaries in district offices—						
Boston.....	3	4,200	4	5,850	7	12,040
Chicago.....	3	4,650	3	5,200	8	14,040
New Orleans.....	2	2,800	2	3,000	3	6,000

a These positions provided for under statutory appropriation.

b Including employees serving less than a year and those on nominal salaries.

APPROPRIATIONS FOR THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS ENDING JUNE 30, 1918 AND 1919, AND ESTIMATES FOR THE YEAR ENDING JUNE 30, 1920—Continued.

Appropriations and classes of work.	1918		1919		1920	
	Employ-ees.	Amount.	Employ-ees.	Amount.	Employ-ees.	Amount.
Promoting commerce—Continued.						
Maintenance of district offices—Con.						
Salaries in district offices—Con.						
New York.....	10	\$13,800	11	\$14,020	22	\$32,960
Division of commercial agents.	3	4,400				
San Francisco.....	2	3,100	2	3,700	4	7,180
Seattle.....	2	3,000	2	3,300	4	7,180
St. Louis.....	2	3,000	2	2,860	4	7,180
New offices contemplated.....					16	26,720
Miscellaneous, including rent, traveling expenses, supplies, cablegrams, temporary clerical assistance, etc.		6,060		11,580		166,960
Total.....	52	125,000	46	125,000	96	435,000
Commercial attachés:						
Office staff.....					(a)	(a)
Salaries, commercial attachés, clerks, and expenses—						
Denmark (Copenhagen).....			2	10,000	2	14,800
France (Paris).....	2	10,000	2	10,000	2	13,200
Netherlands (The Hague).....	2	10,000	2	10,000	2	13,800
Italy (Rome).....			2	10,000	2	13,800
Mexico (Mexico City).....					2	18,800
Russia (Petrograd).....	2	10,000				
Spain (Madrid).....			2	10,000	2	14,800
United Kingdom (London).....	2	10,000	2	10,000	2	13,200
Argentina (Buenos Aires).....	2	10,000	2	12,000	2	14,200
Brazil (Rio de Janeiro).....	2	10,000	2	10,000	2	14,200
Chile (Santiago).....					2	14,800
Peru (Lima).....	2	10,000	2	11,000	2	12,200
China (Peking).....	2	10,000	2	12,000	2	14,200
Japan (Tokyo).....	2	10,000	2	10,000	2	13,200
Australia (Melbourne).....	2	10,000			2	12,800
Canada (Ottawa).....					2	12,800
Cuba (Habana).....					2	15,800
Greece (Athens).....					2	13,800
Russia (Moscow).....					2	15,800
Panama (Panama City).....					2	12,800
Miscellaneous, including contingent expenses.....		9,000		10,000		8,500
Total.....	20	109,000	22	126,000	38	272,000
Latin America:						
Office staff.....	18	26,700	18	29,350	(a)	(a)
Field investigators.....	14	66,000	10	66,000	12	113,324
Miscellaneous, including contingent expenses.....		8,300		5,650		11,676
Total.....	32	100,000	28	100,000	12	125,000
Far East:						
Office staff.....			3	6,550	(a)	(a)
Field investigators.....			7	37,000	14	130,102
Miscellaneous, including contingent expenses.....				6,450		6,866
Total.....			10	50,000	14	137,000
Development of trade through motion pictures:						
Showmen and lecturers.....					6	19,500
Miscellaneous.....						49,500
Total.....					6	69,000
Grand total.....	217	488,120	219	564,120	366	1,365,470

^a These positions provided for under statutory appropriation.

^b Including employees serving less than a year and those on nominal salaries.

The following table gives the number of employees in the Bureau of Foreign and Domestic Commerce during the years 1912 to 1919. It shows that in the fiscal year that has just closed the number of lump-sum employees was 104 and those holding statutory positions 113, while during year 1919 the force paid from lump-sum appropriations will probably reach 106 persons, with 113 statutory employees:

EMPLOYEES OF THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS 1912 TO 1919.

Year ended June 30—	Employees under lump-sum appropriations.											Regular statutory force of Bureau.		
	Promoting commerce.		Promoting commerce with South and Central America. ^a		Investigating cost of production. ^a		Commercial attachés.		Promoting commerce in Far East.		Total lump-sum employees.			
	Em- ploy- ees.	Appro- pria- tion.	Em- ploy- ees.	Appro- pria- tion.	Em- ploy- ees.	Appro- pria- tion.	Em- ploy- ees.	Appro- pria- tion.	Em- ploy- ees.	Appro- pria- tion.		Em- ploy- ees.	Appro- pria- tion.	
1912...	11	\$60,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	102	\$110,600
1913...	12	60,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	103	\$114,800
1914...	16	60,000	.....	.....	13	\$50,000	.....	.....	.....	.....	.....	29	108	\$114,800
1915...	34	75,000	17	\$50,000	18	60,000	20	\$100,000	.....	.....	.....	89	89	122,180
1916...	33	77,000	35	75,000	18	60,000	20	100,000	.....	.....	.....	105	86	119,280
1917...	43	125,000	32	100,000	22	60,000	20	100,000	.....	.....	.....	127	95	130,640
1918...	52	125,000	32	100,000	.....	.....	20	100,000	.....	.....	.....	104	113	154,120
1919 ^e ...	46	125,000	28	100,000	.....	.....	22	125,000	10	\$50,000	.....	106	113	154,120

^a Exclusive of temporary employees.

^b Including 6 employees paid out of tariff appropriation; later transferred to statutory positions.

^c Including tariff appropriation (\$10,000).

^d Including 2 positions in the Bureau provided for by appropriation act.

^e In part estimated.

CONCLUSION.

Considering that the service rendered in this year on which I have reported has run concurrently with extraordinary statistical and research work of unlimited quantity for the various war boards, you will appreciate more fully the scope of the Bureau's contribution for the past year. The work requested of us by the War Trade Board, the War Industries Board, and the Shipping Board helped to form the nucleus of their research and statistical equipment, to which we are glad to contribute. To the President we are indebted for an assignment of funds out of the National Security and Defense Fund in his hands for the employment of extra facilities for war-time statistical activity, and we shall render to him more than full return for the investment.

Only brief mention may be made of our other activities, such as purchases of foreign raw materials for the Army and Navy, the advisory service on war-time legislation, the endeavor to help numerous manufacturing concerns out of war-time difficulties, the organization of foreign service for other branches of the Government, and participation in plans for commercial education in many parts of the Union. The splendid organization and spirit of the Bureau has made this variety of work possible. We subscribe to your often expressed hope that the Bureau's force may be preserved intact and amplified until its proportions measure up to the rightful claim of

the business public for a national headquarters such as certain other activities of our people enjoy. The fact has not escaped us that other nations are now busily engaged in building up their economic integrity through the agency of new commercial departments under the control of their central governments. The whole world is taking an economic view of the relations of man to man and people to people. Many of the plans are modeled in part on the successful procedure of this Bureau. We aspire to the same leadership in the future that we have exercised in the past, and we are quite confident of our ability to aid the commercial interests of the country in maintaining the solid position which they now occupy.

Respectfully,

BURWELL S. CUTLER,
Chief of Bureau.

TO HON. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
DIRECTOR OF THE BUREAU OF STANDARDS

245

NATIONAL BUREAU OF STANDARDS

Washington, D. C.

1918

FUNCTIONS

**Development, construction, custody, and maintenance
of reference and working**

STANDARDS - - - - -

**and their intercomparison, improvement, and application
in science, engineering, industry, and commerce.**

REPORT

OF THE

DIRECTOR, BUREAU OF STANDARDS.

DEPARTMENT OF COMMERCE,
BUREAU OF STANDARDS,
Washington, July 1, 1918.

SIR: There is submitted herewith a report of the work of the Bureau of Standards for the fiscal year ended June 30, 1918.

I. FUNCTIONS, ORGANIZATIONS, AND LOCATION.

Before describing in detail the various scientific and technical problems in which the Bureau of Standards is engaged, the following brief statement as to its functions and organization may be helpful to those unfamiliar with the subject of standardization in the broad and modern sense.

The standards with which the Bureau is authorized to deal may be conveniently classed as follows: Standards of measurement, standard values of constants, standards of quality, standards of mechanical performance, and standards of practice.

I. STANDARDS OF MEASUREMENT.

A standard of length may be taken as an example of a standard of measurement. It must be a length which is unchanging, reproducible, and capable of being compared with the working standards used in the most precise scientific work or with those used in commerce and industry. The fundamental standard must be subdivided and working standards prepared of these parts, and for the measurement of greater lengths standards must be prepared which are multiples of the fundamental standard. This process of subdividing and multiplying the standard involves difficulties as great as those met with in the preparation of the fundamental standard itself.

The construction of a set of standard weights from a single unit is also an illustration; a whole set of standard weights must be prepared before the standard weight of the Government can become available to the public. When the standard of length or weight has been found with as many desirable qualities as possible, and before the working standards of the subdivisions or multiples can be prepared, the question as to the method of comparison arises, which again involves the solution of difficult scientific problems in connection with the balance or the methods used. These balances range from that capable of measuring the thousandth part of a milligram to the large testing machine capable of measuring a load of thousands of tons. The complete range must be covered, which involves

not only a large number of working standards, all of which must agree with the fundamental standard, but apparatus suitable for the comparison of these standards with all of the lengths or weights found in practice.

These steps and equipment are absolutely essential in order to secure uniform measurements of length or weight throughout the country, and they have their counterpart in every quantity that has to be measured, whether it be length, weight, temperature, heat, light, or the various electrical measurements or other standards of measurement. These standards in one form or another are involved in practically every scientific investigation, industrial process, engineering structure, or commercial transaction.

2. PHYSICAL CONSTANTS.

There are many fixed relations between physical quantities, the values of which it is extremely important to know. These values are usually termed "physical constants," and are used in every branch of scientific work or industry. The amount of heat required to change a pound of water into steam under normal conditions and the relation between heat and mechanical energy are two important physical constants; their values are used in practically every computation in connection with the designing of steam engines and boilers, the tests of their efficiencies, or the measurement of their output. The amount of heat required to turn liquid ammonia into vapor or the amount of heat required to melt a pound of ice are constants equally important in the refrigerating industries. The value of the relation between electrical and mechanical energy is involved in many important commercial transactions concerned in electricity.

Accurate and authoritative values of these constants are just as essential as in the case of standards of measurement. Many of these now in use are old and obsolete and need redetermination by means of the best modern facilities for physical measurement. Their determination involves the most difficult and precise work in all branches of physics and chemistry—a fact not generally known by those not engaged in the scientific or technical work where these constants are used.

3. STANDARDS OF QUALITY.

A standard of quality for a given material may sometimes take the form of a sample of that material with which other materials of the same kind can be compared, but this is generally a makeshift of the poorest sort. It is only resorted to in the absence of definite and reliable specifications in terms of measurable properties; that is to say, a standard of quality of a material usually takes the form of a specification or definition of its properties, involving, of course, the measurement of those properties by means of the usual standards of measurement. A certain kind of steel, a cement, a paint, an oil, or a paper or cloth is found by use to be good or poor. The questions then arise, Why is it good or poor; What are the physical or chemical properties or the particular combination of elements which make it of good or poor quality; How are its properties to be measured or its constituents determined? These are questions for the laboratory to answer and involve physical and chemical investigations of the most difficult sort.

A standard of quality for a given material necessarily takes into account the purpose for which the material is to be used; to set the standard too low results in losses, poor efficiency, and even loss of life; to make it too high may result precisely in the same thing; that is to say, the material must be suitable for the purpose intended, and the Bureau's investigations in connection with the properties of materials are to enable the user of these materials, first, to select intelligently the material best suited for the purpose; second, to specify it in terms which the producer can not mistake; and, third, to make the necessary tests to ascertain whether or not the material supplied is in accordance with the specifications.

The actual testing of materials by the Bureau of Standards to ascertain whether or not they comply with specifications is confined almost exclusively to Government purchases, but in making these tests (in which the Bureau has had the hearty cooperation of practically all the departments of the Government service) it is compelled to make many investigations concerning the properties of materials, their specification and measurement. While this work is of great value in placing Government purchases on a correct business basis, the results of the investigations as to the properties of materials and the information gained in testing Government supplies are even more important to the general public and are distributed in the form of suitable publications.

The Bureau does not compete with private testing laboratories, but endeavors to assist them by the development of standard specifications, methods of measurement, and other matters where uniformity is desirable, much of which information, as stated above, is secured in connection with the testing of materials purchased by the Government and a close observation of their use.

The time is not far distant when it will be required that all materials bought or sold shall be as represented, but it should be kept in mind that this is impossible except in the case of those materials where proper standards of quality and methods of measurement have been developed. It must not be assumed that the purchaser or user is the party principally benefited in the development of such standards; on the contrary, the manufacturer, first of all, is interested in the quality of all things which affect the quality of his product, and while the Bureau's efforts in this field are devoted principally to the pointing out and measurement of those properties upon which the quality of the materials depends, it is to be regretted that its force and equipment are insufficient to render more assistance to manufacturers with a view to a direct improvement of those parts of the process upon which the quality of the output depends.

4. STANDARDS OF PERFORMANCE.

The value of an instrument, device, or machine almost always depends upon the efficiency of its performance. In such cases it is necessary to state the performance desired or guaranteed in terms which are correct and susceptible of measurement. As in the case of standards of quality, the standard involved is more often in the form of a specification, but specifications are useless unless based upon correct scientific and mechanical principles and supplemented with a statement of the method to be used in ascertaining whether or not the specifications or guaranties have been complied with.

The performance of an engine or boiler, a pump, an electrical generator or motor, a weighing device, or a telescope can usually be measured, but the quantities to be measured and the method used must be specified correctly and understood by all the parties concerned in the construction, purchase, or use of such apparatus. To do this properly involves the use of standards of measurement, standards values of constants, and standards of quality. The Bureau of Standards does not attempt to cover this field completely, but only those cases where there is a lack of definite information upon which to base specifications and only to the more important classes of apparatus. To secure this information involves investigations quite as scientific in character and as difficult as in the case of other standards, as well as a knowledge of technical and manufacturing processes.

The Bureau's activities in this field have only been developed to a slight extent and almost entirely in connection with Government purchases. It has had in this, as well as in the field of the properties of materials, the most hearty cooperation of the various Government experts, manufacturers, engineers, and technical societies.

5. STANDARDS OF PRACTICE.

Standards of practice are generally involved in the enactment of laws when technical and scientific matters are concerned, in the ordinances relating to the regulation of public utilities, and in the establishment of building and safety codes. Like standards of performance, they are dependent upon standards of measurement and standards of quality and are of the most vital importance in questions pertaining to the welfare and safety of the public. In a field so broad the Bureau can touch only upon the more important aspects of the work, where national uniformity is desired—fields which can not be covered efficiently in private laboratories.

6. RELATION OF THE BUREAU'S WORK TO THE PUBLIC.

It is perfectly obvious, even to one unfamiliar with the subject, that the maintenance on the part of the Government of correct standards of measurement or quality or performance calls for continuous scientific and technical investigations of the highest grade, involving the most competent expert services and the best scientific equipment. When this is accomplished, there still remains the serious problem of making the results available and useful to the public.

The Bureau compares with its own standards of measurement the standards or measuring instruments of States, cities, scientific laboratories, educational institutions, manufacturers, Government bureaus, or the public, for which a nominal fee is charged, except in the case of the National and State Government institutions. It gives advice concerning these standards or their use, whether it be in connection with the enactment of laws, regulations, or ordinances concerning the weights and measures of everyday trade or in connection with precision standards used in scientific work and the industries. It gives advice upon request to State and city officials, public-service commissions, and public-utility corporations regarding the standards of measurement, or quality, or performance involved in legislation or regulation pertaining to the public utilities. Many questions of

disagreement between the public and utility companies as to these matters are referred to the Bureau for advice or adjustment, often avoiding unfair or inconsistent regulations, as well as long-drawn-out and expensive litigation. There is a great need on the part of the public for unbiased and reliable information pertaining to the standards entering into the regulation and sale of the services of public utilities. As far as possible such information is given in the form of publications upon definite subjects.

It must not be inferred from the above that the Bureau's activities are devoted principally to the interests of the user or consumer. The fundamental facts regarding standards of measurement, quality, or performance are the very things which most deeply concern manufacturers; they are fundamentally concerned, either directly or indirectly, with the improvement of methods of production or the quality of the output. It may be said that the Bureau occupies somewhat the same position with respect to the manufacturing interests of this country that the bureaus of the Department of Agriculture do to the agricultural interests. Many industries are just beginning to realize the importance of precise methods of measurement and scientific investigation, which, in practically every case, involve some kind of measurement.

It is upon quality as well as upon price that competition must finally depend, whether in domestic or foreign commerce. The use of exact methods and scientific results is the greatest factor in the improvement of quality, efficiency, or the development of new industries. The educational value of the Bureau's work in this respect is almost entirely unknown to the general public, and yet the Bureau receives hundreds of letters, as well as many personal visits from manufacturers, seeking information as to standards of measurement, how to use them, how to measure the properties of materials, or as to the fundamental physical and chemical principles involved; also, what is of even greater importance, how to initiate and carry out scientific investigations and tests on their own account in their particular fields of work.

The importance of maintaining scientific institutions having to do with standardization and the application of precise measurements to the industries has been recognized by all the leading countries of the world. Great Britain maintains the Standards Department of the Board of Trade, which is in charge of the standards and inspection service of the trade weights and measures; also the National Physical Laboratory, whose functions include matters pertaining to scientific and technical standards, physical constants, and to some extent the properties of materials. The Laboratoire d'Essais, of France, while not as extensive as the English institution, is charged with similar duties. Germany maintains three such institutions—the Normal-Eichungs Kommission, equipped with the buildings, personnel, and apparatus necessary in standardizing and controlling the weights and measures of trade; the Physikalisch-Technische Reichsanstalt, covering testing and investigations in connection with scientific and technical standards other than weights and measures; and the Prussian Government maintains the Materialprüfungsamt, a large institution devoted to the investigating and testing of structural, engineering, and other materials.

It is generally recognized that these institutions have been exceedingly important factors in the industrial progress of these countries.

7. RELATION OF THE BUREAU'S WORK TO THE GOVERNMENT SERVICE.

The bureaus of the Government engaged in scientific and technical work are necessarily dependent upon standards of measurement of every variety. In addition, many of them are engaged in the design, construction, and specification of a great variety of special apparatus, in which the principles of mechanics, heat, optics, electricity, and chemistry are involved and are vital to their efficiency and successful operation. In such matters the Bureau has been consulted most freely by the War and Navy Departments, and various other military departments of the Government, including the Railroad Administration, Shipping Board, Fuel Administration, Food Administration, and National Advisory Committee for Aeronautics; also the Post Office Department, the Department of Agriculture, the Public Health Service, and others.

The engineering and building construction in progress at all times by the Government is exceedingly great, both in variety and magnitude; in all of it a knowledge of the materials employed is of fundamental importance from the standpoints of economy, efficiency, and safety. The work of testing and investigating the properties of structural materials was taken up and is carried on primarily for the purpose of securing the information needed by the Government service in its structural work. This information is as necessary to the public in construction work, and every effort is made by the bureau to make its findings in a form available to the public generally. The demands for information of this sort have come from practically all Government bureaus and establishments, but especially so in connection with the structural work carried on by the Office of the Supervising Architect, the engineering branches of the Army, the Bureau of Construction and Repair of the Navy, the Panama Canal, and the Reclamation Service.

The Bureau of Standards serves as a testing bureau for the various departments of the Government when called upon, and as such is assisting to place Government purchases upon an economical and businesslike basis. The example of the Government in such matters has a far greater influence upon the public than is generally supposed. The Government can do no greater service to the country than to place its own purchases upon a basis which may be taken as a standard by the public at large. This work involves the specification of a wide range of structural and miscellaneous materials and their testing, when delivered, to ascertain whether or not they comply with the specifications. This is especially important, since such materials are purchased by means of competitive bids, a method resulting in much fraud and injustice unless suitable standards are established and successful bidders held absolutely to this standard in making deliveries. Furthermore, most purchasing officers are realizing the great importance of having such testing done by a disinterested institution equipped with the scientific and other facilities for performing the service in a manner that is fair to both parties concerned in the purchases.

Among the many Government bureaus and establishments which have utilized the Bureau of Standards as a testing institution in connection with the purchase of supplies may be mentioned the Government Printing Office, in connection with the purchase of paper, inks, and printing supplies; and the Post Office Department, in connection with the purchase of paper, twine, textiles, etc. A wide range of materials has been tested for the Quartermaster's Department of the Army, the Paymaster's Department of the Navy, and the Panama Canal. The General Supply Committee has called upon the Bureau for assistance in the specification of all sorts of supplies and equipment, as well as the testing of samples submitted by bidders of the supplies bid upon. Practically every branch of the Government service, including the District of Columbia, utilizes the Bureau of Standards as a testing bureau. Here again, as in other fields of the Bureau's activities, it gains much useful knowledge which is given to the public in the form of suitable publications.

Many bureaus of the Government service are charged with the administration of laws and the establishment of regulations in which scientific data are vital. This is true to a much greater extent than is generally supposed. The Bureau of Standards has cooperated freely with such branches of the Government and the service rendered has involved every department of physics and chemistry covered by the Bureau's activities. The neglect of such matters in the past has been a frequent source of misunderstanding and litigation between the Government service and the public. Conspicuous examples of bureaus to which such assistance has been given are the Customs and Internal Revenue Services; the Steamboat-Inspection and Coast Guard Services, in the promulgation of safety regulations; and the Bureau of Navigation of the Department of Commerce, in the administration of laws regulating the use and inspection of radiotelegraphy.

2. ORGANIZATION.

The organization of the Bureau's scientific and technical staff is based upon the nature of the expert service involved rather than upon the classes of standards. For example, the division of weights and measures has to do with all matters pertaining to standards of length, mass (weight, as it is commonly termed), time, density, and similar questions, whether they arise in connection with the precision standards used in scientific investigation, the master standards of manufacturers, or the ordinary weights and measures of trade. A standard of quality or performance where any of the above measurements form the fundamental and most important factor would be referred to this division.

The division of heat and thermometry has to do with heat standards, the testing of heat-measuring apparatus, the determination of heat constants, of which there are many, and all investigations pertaining to quality or performance where heat measurement is the essential and predominating factor.

Similarly, the electrical division is concerned with all the electrical problems that may be taken up at the Bureau, whether in connection with the various electrical standards of measurement, electrical constants, the electrical properties of materials, or the performance of electrical equipment.

Questions in optics enter into standards of all kinds to a greater extent than has been supposed; hence, there is an optical division provided, with experts in spectroscopy, polarimetry (used in sugar analysis), color measurement, the principles of optical instruments, and the measurement of the optical properties of materials.

Practically all investigations concerning the various classes of standards involve chemistry in one form or another. There are also many chemical standards and questions which arise in connection with chemical work generally, especially in the industries; hence, there is a chemical division, cooperating with every other division of the Bureau, as well as taking care of the questions of a purely chemical nature that come to the Bureau and which fall within its functions.

In the case of the more important technical fields, divisions have been formed dealing more specifically with large and important classes of materials, but many of the purely scientific questions involved would be handled by one of the above-mentioned scientific divisions or jointly with it. The work of the technical divisions is just as scientific in character, but deals more specifically with manufactured products.

The work of the structural engineering and miscellaneous materials division includes the investigation, testing, and preparation of specifications for these materials, such as the metals and their alloys, stone, cement, concrete, lime, the clay products, paints, oils, paper, textiles, rubber, and other miscellaneous materials.

The division of engineering research makes investigations and tests regarding the performance and efficiency of such instruments, devices, or machinery as the Bureau may take up that do not fall directly under one of the scientific divisions. The division is a small one and its work is devoted almost exclusively to assistance given other departments of the Government and the General Supply Committee in designing, specifying, or testing equipment. It should in time form one of the more important branches of the Bureau's work.

The questions pertaining to the manufacture, specifications, testing, and use of the metals and their alloys have become so important that a division known as the metallurgical division has been formed of the experts engaged in these problems.

The employees engaged in clerical work, purchasing, files, records, accounting, and library are known as the office division, while those employed in the operation of the mechanical plant, the various shops, and the care of the buildings and grounds form the engineering and construction division.

9. LOCATION.

The laboratories of the Bureau of Standards are located in the northwest section of Washington, on Pierce Mill Road, near Connecticut Avenue, and are reached by the Chevy Chase car line. They were located outside of the business center of Washington in order to insure freedom from mechanical, electrical, and other disturbances common to the business and more thickly populated sections of the city. Furthermore, the area of ground necessary precluded a site near the city. It has been found by experience that the efficiency of the employees, especially those engaged in testing and scientific investigation, has been greatly increased by the location of the laboratories in a section free from the ordinary disturbances of city life.

II. SCIENTIFIC AND TECHNICAL DIVISIONS.

1. WEIGHTS AND MEASURES.

[Length, area, volume, mass, density, pressure, and time, including researches on units and standards, measuring methods and instruments, specifications and tolerances, and the standardization incident thereto for inspectors of weights and measures, manufacturers of measuring appliances, scientific and technical laboratories, Government bureaus, engineers, and the general public.]

LENGTH.

(The design, improvement, and investigation of length-measuring apparatus, calibration and test of yard bars, meter bars, geodetic tapes, level rods, haemacytometer apparatus, cement sieves, expansivity of solids.)

Military Work in Connection with Weights and Measures.

Other work having a military bearing, yet proper to be mentioned here, includes the following:

In connection with the test of coke ovens the Division of Weights and Measures tested and adjusted the railroad track scales used for weighing the coal, etc., used in the test. Parts of a new ordnance design were weighed and the position of the center of gravity determined for the Ordnance Department. Considerable consulting work has been done in relation to tolerances on screw threads, investigation of systems for screw-thread tolerances, and improvements in design of measuring machines.

Cooperation has been afforded in the design of precision micrometers of two types, one for measuring outside dimensions and one for measuring inside dimensions, manufactured for the bureau by the Mount Wilson Solar Observatory. An arrangement of projection lantern has been devised for the determination of the angles of screw threads, which is a great improvement over the apparatus previously employed in this work.

A contact indicating device has been designed and constructed which is found to be very sensitive and gives promise of many useful applications; a torque measuring instrument for use in connection with precision micrometers has been constructed, and the specifications and general features of design for an end standard measuring machine were worked out in conference. A new method for determining the paths of artillery projectiles in flight has been proposed and turned over to the military authorities. This division is also cooperating in the development of a device for synchronizing machine guns to shoot between the aeroplane propeller blades and an investigation of a machine for gauging rifle barrels is now being conducted.

This division has also conducted a research to determine the elastic indentation which takes place when spherical surfaces are employed, as they are in much of the gauge-standardization work, and the correction resulting from the indentation has been determined.

Many computations have been made covering such subjects as the springs used in machine gun adjustments, tables for use in measuring

screw threads, table for constants for the three-wire method of screw measurement, and a table of metric equivalents, which now has been published as a supplement to Circular No. 47.

A few communications have been issued in connection with military work, among which may be mentioned one which calls attention to some fundamental misconceptions regarding use of screw-thread gauges, two on the precision test of micrometers, and one on symbols for screw-thread notation. This last has been adopted by the Committee on Screw-Thread Tolerances of the American Society of Mechanical Engineers.

Additional Consulting Work.

In addition to the consulting work on track scales and testing equipment and on specific military problems, the Bureau has done work of similar character in reference to the use of spring scales for investigating quarry stone under the Office of Public Roads; depot and wagon scales for the Engineer Corps of the Army; platform scales and parcel-post scales for the Post Office Department; specifications for freight-house scales for the Southern Railway; specifications for hopper scales for the Pennsylvania Railroad and for the American Railway Association; specifications for hopper scales for manufacturers; an invention for obtaining an automatic compensation for automatic grain scales for the inventor and manufacturer; prescription scales for the Medical Supply Depot of the Army; investigation of a new design of flexure plate scale for parcel-post work; design of 5,000-pound weights for the New York Central Railroad; autotruck scales, wagon scales, paper weighing scales, platform scales, and specifications for 500-pound standard weights, these requests coming from various sources.

A series of charts for computing scales were examined and report rendered to a manufacturer of computing scales. A careful study of a mechanical device for measuring cloth was made for the manufacturer, special attention being paid to its acceptability for use in trade.

Length Measures.

During the fiscal year 2,071 tests for accuracy of linear measurements were made upon the following articles:

Line standards and measuring scales (tested or ruled).....	27
Tapes.....	695
Level rods.....	29
Sieves.....	51
Samples of sieve cloth.....	14
Polariscope tubes.....	46
Hemacytometer chambers.....	228
Micrometer calipers, vernier calipers, end standards, disk gauges, etc., for the equipment of the gauge section.....	919
Miscellaneous articles.....	62

Observations were completed on six State standards of length, a complete calibration of a bar for the electrical division of the Bureau was made, and 24 intervals on a Pratt & Whitney bar were determined.

Among the miscellaneous articles to which length tests were applied were slotted drums for an oscillograph timer, a master chart for compass dials, Johansson gauge blocks, steel balls, and viscosimeters. Besides the routine testing and the investigations noted,

mention should be made of a considerable number of informal tests and investigations for the gauge section, for other divisions of the bureau, and for the Army.

A thorough investigation and test was made of an end comparator at the Washington Navy Yard with a view to ascertaining whether the apparatus was suitable and sufficiently accurate for the work being done upon it. The results showed that a more accurate comparator was needed, and one is being purchased for this work to conform to recommendations made by the bureau. A careful calibration was also made of a Gaertner comparator for the gauge section of the bureau.

Special investigations were made also of the accuracy of the large dividing engine and of the special end comparator in use in the Bureau.

Hæmacytometers.

During the previous fiscal year the test of hæmacytometer chambers and pipettes was taken up and specifications were prepared for the test of this apparatus. These are important instruments widely used by physicians and bacteriologists in counting the number of corpuscles in a given quantity of blood. Close cooperation has been had with the manufacturers, and during the past year two prominent manufacturers of hæmacytometers visited the bureau for consultation. As a result of the bureau's work, there has been a gratifying improvement in the instruments submitted for test. These instruments are extensively used by the medical departments of the Army and Navy, and in one lot of instruments submitted for Government use excessive errors were found in the chambers. A special device is being designed to facilitate the test of these instruments.

Expansion of Insulating Materials.

Numerous synthetic insulating materials such as "bakelite," "condensite," "formica," etc., have been tested and heat treated to obtain necessary information in connection with the Bureau's spark plug investigations. It has been shown that, without exception, the colloidal substances mentioned above are not suitable for use in delicate apparatus which may be subjected to temperatures above 60° C. The thermal expansion soon vanishes and continued treatment shows marked contraction and loss of weight of the specimen. A paper on this subject will soon be prepared. Specimens of tile and porcelain were also investigated for their thermal expansion properties.

New Equipment for Measuring Expansion.

A new furnace having a limiting temperature of 1,000° C. has been installed, and tests were made above 900° C. in connection with investigations on steel for machine guns. This new furnace has been equipped with an improved thermocouple. With this thermocouple, which is incorporated in a single tube, it is possible to determine temperatures at the center of either end of the furnace, also to make differential determinations for any combination of the three points. The set-up, in general, is a decided improvement over earlier arrangements for the work. The shape of specimens used in expansion measurements has been modified to eliminate all possibilities of errors

due to rust or blisters forming between the specimen and the drop wires at high temperatures.

Length Testing.

The following table gives a summary of the thermal expansion tests made during the year:

Materials.	Number of Samples.
Aluminum-copper-magnesium alloys.....	2
Zinc-aluminum alloy.....	2
Bakelite, continental.....	1
Bakelite, dilecto.....	5
Bakelite, micarta.....	2
Condensite.....	3
Formica.....	4
Copper alloys.....	61
Molybdenum.....	1
Nickel steel.....	4
Tile.....	1
Verillite.....	2
Porcelain.....	17
Marble.....	3
Silicon steel.....	1
Steel.....	4
Steel (machine gun).....	2
Total.....	115

Six aluminum alloys tested in cooperation with the Metallurgical Division were under consideration as possible materials for airplane construction. The copper alloy work has progressed far enough to show a definite mathematical relation between the coefficient of expansion and percentage of alloying metals.

Special War Problems.

(a) Assistance was given the Signal Corps in correcting certain defects in the range-finding mil scale used in officers' field glasses. The Bureau also cooperated with the Navy Department in improving the quality and quantity of mil scale production at the optical shop annex. Master plates used in making the above scales have been constructed giving the ranges in meters and yards on each scale.

(b) A new type of direct reading micrometer gauge was designed and constructed for special requirements of the Surgeon General's Office. Values correct to one-thousandth inch are shown automatically.

(c) Errors in Brinell microscope scales used in testing the hardness of iron have been located.

(d) Computation and introduction of metric range values for mil scales.

MASS.

(The preparation of specifications and tolerances for weights and balances, improvement in design of balances, solution of fundamental problems arising in connection with weighing; examination and test of precision weights and balances and design of weights.)

Weights and Balances.

A new classification of weights, together with new specifications, and new regulations and fees for testing standard weights were put into force in December. Because of unavoidable delays in complet-

ing the new edition of Circular No. 3, this new classification and the regulations were issued in abbreviated form in a mimeographed pamphlet.

New Material for Small Weights.

In view of the present scarcity of platinum and its urgent need for other technologic work in which no satisfactory substitutes are available, this Bureau early approved the use of gold for weights of 500 milligrams and less. Since then, "rhotanium A" and "palau" have also been approved for use in sets of high-grade analytical weights, such as are included in class S of this Bureau's classification. A brief announcement in regard to these facts was sent to all makers and dealers who could be reached. The War Industries Board now refuses to release platinum for use in making such weights.

New Method of Testing Weights.

In continuation of the plans for shortening the time required in the testing of ordinary analytical weights there was purchased a high-grade assay balance equipped with a device by which a special set of weights can be applied from without the case. On account of certain defects which developed in this balance, the method was not at first wholly satisfactory. The difficulties in details have now been largely overcome. It appears that the method will ultimately succeed in saving a considerable amount of time.

Routine Weight Testing.

Testing of this character carried out during the year was somewhat less in amount than during the preceding year. Standards were tested for six States and for a number of different offices of the Federal Government. The latter include the Ordnance Department and the office of the Surgeon General of the Army, the Director of the Mint, the Bureau of Mines, the Bureau of Ordnance and the Office of Inspector of Hull Material of the Navy Department, and several others. An increasing amount of work has also been done for other divisions of the Bureau.

TIME.

(Origin and improvement of methods of test, and the testing of watches, clocks, and chronometers, and preparation of specifications therefor.)

Time-Measuring Devices.

The work of the Time Section has increased very greatly over that of the previous year. The increase has been primarily due to the requirements of the United States Shipping Board for ship watches, or high grade watches of proved quality to be used on ships of the Emergency Fleet in place of marine chronometers, which are unobtainable in the numbers required, and for ship clocks, and to a demand by the Ordnance Department, United States Army, for accurate stop watches.

On account of this urgent war work the regular class A tests scheduled for August, 1917, and each succeeding three months were canceled, only one test for this class of watches being held during the fiscal year. This was begun on April 25, with 25 watches submitted.

A summary of the year's work follows:

	Number tested.
Class A watches.....	25
Researches for Government Bureaus.....	52
Researches for Time Section.....	7
Ship watches.....	533
Ship clocks.....	745
Airplane clocks.....	71
Stop watches (precision test).....	4
Stop watches (ordinary test).....	3,743
Miscellaneous tests.....	2
Total.....	5,202

Of the 25 watches submitted to the class A test, certificates were granted in the case of 9, all of which were of American make; certificates were refused in the case of 15 watches, of which 3 were of European and 12 of American make.

Continuous assistance in an advisory capacity was rendered the United States Shipping Board throughout the first part of the year in the purchase of navigation instruments. This included the preparation of the major portion of the specifications for ship watches. The Bureau also assisted in preparing specifications for certain airplane watches.

During the year a number of Government Bureaus submitted specifications for timepieces for test, and asked for reports on their performance, with a view to drawing up suitable specifications. Recently the Bureau has been asked to prepare specifications for factory tests of timepieces and to do "calibration testing" as a key to the performance in special phases which are not included in factory tests. The outlook is very encouraging for a wider application of the Bureau's specifications and a greatly increased use of its facilities for testing timepieces.

CAPACITY AND DENSITY.

(Design and improvement of apparatus and methods of test, preparation of specifications for, and testing of glass volumetric apparatus, capacity measures and hydrometers, measurement of density and thermal expansion of liquids, density of solids.)

Capacity and Density.

The following is a summary of the volumetric apparatus tested during the year:

	Number submitted.	Number rejected on preliminary examination.	Number tested.
Metal capacity measures.....	140	.....	140
Burettes.....	275	20	255
Cylindrical graduates.....	69	5	64
Dilution pipettes.....	438	11	427
Flasks.....	590	216	374
Transfer pipettes.....	643	114	529
Measuring pipettes.....	94	4	90

Of the volumetric apparatus submitted for test 60 per cent passed the test, while of that actually tested 72 per cent passed.

One thousand three hundred and nineteen hydrometers were tested, an increase of 35 per cent over last year. Sixty-seven per cent

of the hydrometers submitted passed the test, while of those actually tested 71 per cent passed. In addition 1,100 sugar flasks were tested, 100 miscellaneous tests were made, and the work of inspecting and testing a lot of 216 cylindrical graduates is well under way.

Two hundred and twenty-four density determinations were made on various substances, representing an increase of 45 per cent for the year.

Density Researches.

Density determinations were made on several samples of sea water and other sodium chloride solutions in cooperation with another section of the Bureau. The data obtained in this work will be useful in problems of oceanography. Several samples of sodium chloride solutions of various concentrations have been prepared for the completion of an investigation on the density-concentration relation and for the purpose of establishing a percentage scale for salt solutions for use in the manufacture of hydrometers to be used in the pickling industry.

During the year several firms interested in the manufacture of dilution pipettes sent representatives to the Bureau for conference and information on our method of testing such pipettes. The dilution pipettes recently submitted show an improvement over those submitted in the early part of the year, indicating that the manufacturers are producing a better grade of pipettes.

Several of the manufacturers of other glass volumetric apparatus have visited the Bureau and spent some time in studying our methods of testing volumetric glassware.

GAS-MEASURING INSTRUMENTS.

(Design and improvement of apparatus, and the investigation and improvement of methods of tests of gas meters and meter-proving apparatus and other instruments used in connection with the flow of gases; testing of meters and meter-proving apparatus.)

Gas Measurement.

The gas-measuring section has made tests of six dry gas meters for use in war work by different branches of the Government and furnished information and advice from time to time regarding the measurement of gas in small and large quantities. The improved type of portable cubic-foot apparatus for calibration work, developed by this section, has been used in the investigational work of the Gas Warfare Division of the Army, and a considerable number of these instruments have been constructed for this purpose.

This section has cooperated with different branches of the naval and military service with considerable success, a part of this work being of a confidential nature.

WEIGHTS AND MEASURES LAWS AND ADMINISTRATION.

(Cooperation with States in the administration of weights and measures laws; promulgation of specifications and tolerances for apparatus, and of rules and regulations; enforcement of standard barrel laws; conducting weights and measures investigations; annual conferences of State and local officials on weights and measures.)

General Weights and Measures Legislation.

Several States have enacted amendments strengthening their code of weights and measures laws during the past year. No national weights and measures legislation has been passed, but there is now

before Congress a bill designed to standardize packages of flour, which has the hearty support of this Bureau and also of the milling trade in general. By the terms of this bill the 100-pound package is made the standard, and all other packages are required to be a multiple of 100 pounds, or one of the following fractional parts thereof, viz, 50, 20, 10, 5, 4, 2, or 1 pound. This bill eliminates the present odd-size barrel of 196 pounds and its subdivisions, 98, 49 or 48, 24 or 24½, 12 or 12½ pounds, etc. It therefore simplifies the package units very much and provides for uniform packages throughout the country, a condition which does not exist at the present time on account of conflicts in State laws and of the customs of trade.

Cooperation with States and Other Interests in Weights and Measures Administration.

This feature of the work, which has proved to be of the greatest utility in obtaining the proper and uniform enforcement of weights and measures laws in the past, has been continued in so far as possible during the present year. While it was deemed advisable again to postpone the session of the annual conference on weights and measures on account of congested conditions on the railroads and in Washington and on account of the greatly increased work devolving upon the Bureau staff and upon State and local officials on account of the war, assistance has been rendered in other ways whenever practicable. Representatives of the Bureau have attended State conferences in Indiana, Maine, Massachusetts, New Jersey, New York, West Virginia, and Wisconsin and have given instruction on subjects of current interest and importance, particular attention being paid to the standard barrel law, which will be enforced largely through the aid of State and local officials. Assistance in solving special problems, such as installation of State weights and measures laboratories and difficulties arising in connection with obtaining and maintaining accuracy in oil pumps and gas, water, and electric meters, has been furnished both at the Bureau and in the field and by correspondence. A publication entitled "Manual of Inspection and Information for Weights and Measures Officials" has been completed and is now in page proof. This should do much toward improving and unifying practices among the various departments throughout the country. Many requests for copies have already been received.

In its work of cooperating with other interests representatives of this Bureau have contributed to other conferences and meetings, among which may be mentioned, in addition to those referred to above, the National Scale Men's Association, the American Society of Mechanical Engineers, where war problems were particularly presented and discussed, and a meeting in Cleveland to discuss the matter of specifications for structural steel for the bridge construction of railroad track scales.

COMMERCIAL SCALES.

(The testing of railroad track scales, elevator scales, mine scales, other commercial scales and weighing and measuring apparatus; specifications for and capacity rating of scales.)

Preliminary Mine-Scale Investigation.

In August, 1917, it was brought to the attention of the Bureau that a serious condition of affairs existed in the coal fields of Alle-

gany County, Md., as a result of disputes continually occurring between the miners and operators in regard to the condition of the scales and methods used in weighing the coal mined by the workers, upon which their wages depended. The miners distrusted the weighings obtained from the scales in use and believed that they were not receiving the full amount of pay to which they were entitled. No method of remedying the situation had been found and it had become so acute that a general strike was impending and would certainly have occurred had not the Bureau promptly intervened and obtained a postponement of this action while an investigation was conducted. This matter was considered to be of the greatest importance on account of the special necessity for continued production of coal at this time, when it is so vitally needed.

No attempt was made to test all the scales in the region, those being selected for test at mines where the friction between operators and employees was most pronounced. As a corollary to the test of scales an investigation was conducted into the matter of average tare weights and others matters closely related to the accuracy of the weights obtained.

It was demonstrated that the grievances of the miners were in many cases well founded. The scales had in many instances been improperly installed, and, again, no proper attention to their maintenance had been given throughout long periods of service. Again, in at least one instance fraud in weighing was very strongly indicated. The result of all these conditions was that very serious errors of use were common—not a single scale examined being within the tolerance allowable in such work; moreover, important errors were in every case in favor of the operator. One scale used to weigh loads of less than 2 tons was out of balance by the extraordinary error of 616 pounds, and one of the counterpoise weights used thereon was in error by 111 pounds on a nominal weight of 1,120 pounds, both errors, of course, resulting in underpayment of the miners for the coal dug by them. In another case two counterpoise weights were found which had been plugged with lead in such a way that errors of 103 pounds and 41 pounds were introduced, the total error on the scale, including other causes, being 166 pounds, this discrepancy again resulting in short weight. Other errors were consequent upon faulty methods of operation, such as the incorrect determination of tare weights of cars.

The representatives of the Bureau were called before the Allegany County grand jury and gave testimony regarding the results of the inspections and tests, and later, indictments having been found, testimony was given in court. In the cases of three scales fines of \$300 and costs were imposed in each case, while in a fourth case sentence was suspended upon the company's action in paying to their workers more than \$2,200, which had been wrongfully withheld on account of the inaccuracy of the weights.

As a result of the above-described circumstances an urgent deficiency appropriation of \$15,000 was granted by Congress for the continuation and broadening of the scope of the work. Also certain changes recommended in the State mining law by the Bureau were incorporated in a bill introduced in the State legislature. While this bill failed of passage, it is understood that many of the proposed

changes were adopted by mutual agreement of the operators and miners. Assurances were given by the companies to the court that attention would be directed to the immediate repair of all scales owned by them in this region and that such scales would thereafter be properly maintained to guard against the recurrence of errors.

Continuation of Mine-Scale Investigation.

When the appropriation for the continuation of the investigation became available steps were taken to build up an inspection force and equip them for efficiently carrying on the work. Two motor trucks of the light aviation type built in accordance with Signal Corps specifications have been procured through the cooperation of that branch of the service for transporting the personnel and equipment required.

During the last month of the fiscal year the investigation has been renewed, the same region being chosen for its inauguration, and the same method of selection of scales being adopted as in the preliminary work.

It has already been demonstrated beyond all doubt that the investigation has been productive of beneficial results, since the conditions here are on the whole enormously better than those which obtained at the time of the preliminary investigation. A general awakening to the necessity of maintaining accurate weighing equipment and properly using the same is evidenced throughout the whole region. Less dissatisfaction appears among the miners than formerly, and they show entire willingness to abide by the decisions of the Bureau.

During the later phase of the investigation it developed that about 45 per cent of the scales tested were installed or repaired in the time intervening between the two visits of the Bureau inspectors. This is a great contrast to former conditions, since at that time nearly all of the scales had been in use for years practically without attention. Thirty-seven per cent of the scales thus far tested have been found to be within the tolerance allowed and the average error and the average shortage on those found incorrect are only about one-third and one-fifteenth respectively of the former figures. Moreover, only about one-half of the incorrect scales are now in favor of the operator, while in 1917 two-thirds were in this condition, and, as stated, the average magnitude of the errors has been materially decreased.

The following shows in brief tabular form the conditions found in this region in the investigations of 1917 and 1918, respectively:

	1917	1918
Per cent of incorrect scales operating in favor of miner.....	38	58
Per cent of incorrect scales operating in favor of operator.....	67	47
Average error of scales operating in favor of miner..... per cent.	0.4	3.0
Average error of scales operating in favor of operator..... do.	9.3	1.7
Average error of all incorrect scales..... do.	7.5	2.4
Average shortage of all incorrect scales..... do.	7.4	0.5

While conditions have greatly improved, the fact can not be overlooked that some of the companies are still maintaining grossly inaccurate scales (one was found which had an error of 350 pounds on a ton in favor of the operator); inaccurate average tare weights are

in use in some cases, and faulty methods of weighing (such as weighing cars in motion, coupled cars, etc.) are occasionally encountered. The county authorities plan to prosecute in all those cases where errors are such as to warrant that proceeding.

While it is probably true that improvements thus far caused are limited to the one district investigated, it may be said that the bettering of conditions here is distinctly encouraging, and it appears that, in general, conditions can be materially improved in this manner and the production of coal thereby definitely stimulated throughout the country.

Railroad Track-Scale Work.

The investigation of railroad track scales and railroad weighing throughout the country has been carried on by the Bureau since 1913. In this work the Bureau now has, generally speaking, the hearty co-operation of the State departments of weights and measures, railroad companies, industrial concerns, manufacturers and shippers, and weighing inspection bureaus, and is constantly receiving requests for tests from all of these sources. The Bureau's scale-testing equipments are generally recognized as far superior to any other scale-testing equipments in the country and the tests made by the Bureau are considered authoritative. As a result the Bureau in many instances is called upon to settle disputes between railroads and shippers.

The war has had a marked effect upon the railroad track-scale-testing work during the last fiscal year. This has been due to two things: First, a considerable portion of the energies of the staff has been applied to direct war problems (the nucleus of the present gauge-testing force of this Bureau was obtained from the railroad track-scale-testing staff); second, the war has altered the status and increased the importance of this work since the Government has taken over the railroads and guaranteed their revenues.

Cooperation with Railroad Administration.

When the operation of the railroads of the country was placed in the hands of the Director General of Railroads, it was immediately apparent that the track-scale work of the Bureau would be greatly enhanced in importance, since the larger part of the revenue of the roads is derived from freight charges levied as a direct result of the indications of these scales. It was the desire of this Bureau to cooperate to the fullest extent with the Railroad Administration in order that the work might be made of the maximum benefit, and accordingly an offer of cooperation was promptly made. This offer was accepted by the Railroad Administration, and Circular No. 13 has been issued by that service, under the terms of which the Bureau is authorized to make tests of any railroad scales or test cars for the purpose of obtaining necessary data and information relative to specifications and tolerances and methods of test of scales. Reports of tests are to be furnished to the railroads and the regional directors concerned.

Testing Equipments for Track Scales.

During the past year the Bureau had in operation 2 track-scale-testing equipments—test cars Nos. 1 and 2—each comprising 100,000

pounds of accurate standardized weights carried in a freight car of special construction equipped with an electric generator for the purpose of developing power for operating the machinery employed in handling the weights and in moving the cars during the test.

In April, 1918, a new scale-testing equipment, consisting of 2 weight units of 40,000 pounds and 80,000 pounds traveling upon their own wheels, was completed and put into operation. These 2 cars are designed to be operated together as one testing unit, and will be satisfactory for testing all commercial track scales when used in a region accessible to a master scale, permitting the checking of the accuracy of the weights at appropriate intervals. The acquisition of these cars makes it possible to employ the other testing equipments largely in the testing of master track scales, for which work they are particularly suited on account of their special design.

Master Scale.

Since the inauguration of the track scale work it has been realized that it would be necessary to provide a master scale to serve as a primary standard for standardizing railroad track scale test cars that would be used in turn as standards for testing railroad track scales on the various lines. Therefore some time ago a master scale was ordered; this is now complete. In connection with this and as a part of the installation of this scale a building will be provided for housing the scale and an auxiliary laboratory equipped for the calibration of test weights used in connection with the test car work, such as the 10,000-pound weights forming a part of testing equipments Nos. 1 and 2, and the 50-pound test weights supplementing the equipments, and for the standardization of test cars Nos. 3 and 4. In addition a shop will be equipped for the general overhauling of the cars which becomes necessary from time to time and to furnish a storage depot for cars and other equipment. This has become especially necessary now, since the two new test cars mentioned are standard weights traveling on their own wheels, and require frequent verification to maintain accuracy consistent with the work of this Bureau. This can only be accomplished on a master track scale.

Tests of Track Scales.

During the fiscal year tests were made in 35 States and in the District of Columbia, as follows: Alabama, Arkansas, Connecticut, California, Colorado, District of Columbia, Georgia, Indiana, Illinois, Iowa, Kansas, Louisiana, Michigan, Massachusetts, Missouri, Minnesota, Montana, Mississippi, North Dakota, North Carolina, New Jersey, New York, Nebraska, Nevada, Ohio, Oregon, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, and Washington.

The scales tested belonged to the Federal Government, State governments, railroads, and industrial concerns.

Master track scales.....	16
Scales owned by railroads.....	291
Scales owned by industries.....	276

Total number of scales tested..... 583

• Forty-two per cent of the track scales owned by railroads and 36 per cent of the track scales owned by industries passed the Bureau

tolerance. This tolerance is based on a maximum allowable error of 200 pounds in weighing a car of 100,000 pounds gross weight. Only 25 per cent of the railroad master scales tested were found to be within the tolerance adopted by the Bureau for scales of that type.

In addition to the tests of railroad track scales and master scales the Bureau's testing equipments were used in the test and calibration of 31 scale test cars owned by railroads.

Detailed reports of the tests were rendered to the owners of the scales. Copies of these reports were frequently sent to other interested parties, as, for example, officials of those States which have organized departments of weights and measures, officers of weighing and inspection bureaus having jurisdiction over scales, chambers of commerce, and the American Railway Association. Most of these reports were rendered directly by the field staff. These reports represent a very important phase of track scale work. They give the results of the test in detail, show the conditions found by careful inspection, and make definite recommendations looking to the correction of such faulty conditions as are present. It was necessary to discontinue the practice of preparing reports in the office on account of the pressure of extra war work.

The owners of the scales have been afforded every opportunity to witness and become conversant with the methods of the tests, and the recommendations included in the reports have, perhaps in the majority of cases, been carried out. In many cases new scale installations have been made, when necessary, as a result of the test and recommendations of the Bureau.

The principal deficiency in reference to the railroad track scale situation has been the great lack of master scales for calibrating the test cars necessary for the proper maintenance of railroad track scales on the part of the railroads. It is believed that when the necessary facilities have been provided for all the roads there will be a marked improvement in the design of scales installed and in the accuracy with which they are maintained. The Bureau purposes giving this matter the fullest possible consideration during the next year. At the present time there are important sections of the country in which no facilities exist for the proper test of railroad track scales, particularly those which are the property of private owners.

Consulting Work on Track Scales.

With reference to track scale specifications the Bureau has been consulted in the matter of drawing up requirements or considering bids by a number of Government agencies, railroads, and industries, among which may be specifically mentioned the Bureau of Yards and Docks of the Navy Department, the Nitrate Division of the Ordnance Department, St. Elizabeth's Hospital (a Government institution), the Virginia Shipbuilding Corporation, and the Railroad and Warehouse Commission of the State of Minnesota. With regard to the last named, specifications were prepared under the direction of the supervisor of scales governing the design and installation of railroad track scales in the State of Minnesota coming under the jurisdiction of the Railroad and Warehouse Commission, as a result of the conference between the representatives of that State and the Bureau.

Capacity Rating of Track Scales.

In connection with the conservation of engineering effort and material and at the same time to avoid deterioration in the product, the bureau plans to make a study of the capacity rating of railroad track scales to aid the manufacturers and railroads in the procurement of weighing equipment which will be adequate for modern needs, and at the same time will eliminate unnecessary variety in the number and character of scales constructed. This work will be pushed as rapidly as the competent technical assistance can be secured.

GAUGES.

(Improvement in the design and use of munition and other gauges, origin and development of methods of test, manufacture and salvage of gauges, examination and test of gauges.)

Gauge Work.

The Division of Weights and Measures has for several years tested and standardized precision length standards and various forms of gauges and measuring instruments for the several branches of the Federal Government and for industrial concerns. In keeping with the program for the rapid production of munitions, this work has been expanded to a large degree in order to provide for the many demands made by the War and Navy Departments and by manufacturers having contracts for war material.

On June 15, 1917, a special war appropriation of \$150,000 for the gauge work of the Bureau of Standards was granted by Congress, and on July 8, 1917, apparatus and equipment were transferred to a special temporary building for the testing of munitions gauges. Apparatus and personnel for testing gauges were assembled at an early date to enable this Bureau to test without delay such gauges as might be submitted. The first lot of munitions gauges was submitted on July 16, 1917.

Practically all of the various lots of gauges have been completed and shipped within three or four days from the time of receipt. In many instances the gauges were received, tested, and shipped on the same day.

The main demands which have been made on the gauge section have been the test and certification of master gauges for artillery ammunition, trench warfare material, and cannon components being produced in large quantities for the Ordnance Department of the Army. A considerable number of gauges have also been tested and certified for the Motor Transport Division of the Army, these being employed in the production of motor trucks. The Signal Corps of the United States Army also submitted during the latter part of the calendar year 1917 a considerable number of master gauges which were for use in connection with the production of aeroplanes and aeronautic instruments. In addition to the work of testing and certifying master gauges for the War Department the Bureau has received a large number of inspection gauges which were submitted by various manufacturers having Government contracts.

The organization of the gauge section includes a shop which was formed primarily for the construction of special apparatus required in the rapid and accurate testing of the more complicated forms of gauges, e. g., thread gauges and profile gauges. The per-

sonnel of this shop being mainly toolmakers and gauge makers, it has been of service in the salvage and building of gauges for exigent needs.

The gauge section has also prepared and distributed technical information pertaining to the methods of test, tolerances, tables for computation, and other essential data for use of gauge makers and gauge inspectors. Blueprints and specifications of special machines designed by this Bureau for measuring gauges have been distributed to manufacturers.

Gauges Tested.

An idea of the amount of work which has been submitted is given in the following table, which indicates the number of gauges that have been received, tested, and certified or rejected during the past year:

1917—July	244
August	473
September	456
October	737
November	1,735
December	1,142
1918—January	2,519
February	1,813
March	3,582
April	4,688
May	4,917
June	5,559
Total	27,865

In the above table about 60 per cent may be classed as plain gauges (plain plug, snap, and ring gauges); about 20 per cent as profile gauges (complicated templets, chamber gauges, and fixture gauges); and about 20 per cent thread gauges. Attention should be called to the fact that of the 27,865 gauges mentioned about 60 per cent were examined for the Ordnance Department, United States Army; 15 per cent were examined for the Motor Transport Division, United States Army; about 10 per cent were on account of the Signal Corps, United States Army; and the remaining 15 per cent were examined for other branches of the Federal Government and industrial concerns having Government contracts.

In addition to the foregoing tests the Bureau has been called upon to inspect at various points in the field numerous gauges used in the production of cannon. In this connection over 300 master gauges were inspected at Rochester, N. Y., for the 75-millimeter field guns, and about 500 master gauges for the 3-inch antiaircraft gun at Philadelphia. About 1,500 gauges have been inspected at the New York City branch of the gauge section of this Bureau since that branch was opened on May 15, 1918.

Work of Gauge Shop.

There have been produced in the gauge shop about 50 machines for measuring screw threads and profile gauges, and various other instruments and accessories for use in connection with measuring instruments. The work of salvaging and manufacturing gauges required for immediate use was started at the request of the inspection division of the Ordnance Department about May 15, 1918. Since

that time about 400 gauges have been salvaged and in the neighborhood of 50 new gauges have been made.

Present Facilities.

At the gauge section of the Bureau of Standards in Washington there is available an organization of about 100 men for the test and certification of all kinds of munitions gauges. There are available also a shop force of about 40 men and shop equipments for gauge manufacture and salvage to the extent of over 50 machine tools. This tool-room equipment with stock accessories represents an outlay of about \$100,000.

In the Branch Gauge Section at New York City there has been duplicated practically all of the various types of equipment available at the Bureau in Washington for the test of munitions gauges. This branch is conveniently located in the Engineers Building at 29 West Thirty-ninth Street. At the present time about 15 men are assigned to the New York branch; this number will be increased whenever the requirements of the work make it necessary. Preparations have been made for the organization of a branch laboratory in Cleveland and one in Bridgeport. The laboratory in Cleveland became available for the test of gauges on July 1, 1918, and the laboratory at Bridgeport will be opened about August 15, 1918.

Suitable increase of facilities at Washington and at the branch laboratories will take place as fast as the needs of the War and Navy Departments and manufacturers are presented.

PUBLICATIONS AND INFORMATION.

(Publications issued on mass, length, capacity, expansivity, and cooperation with States on weights and measures; and mention of miscellaneous information on humidity, nickel steels, tonnage space, and weights and measures apparatus.)

Publications.

The following publications have either been prepared or entirely revised during the year: Circular No. 3, The Design and Test of Standards of Mass; Circular No. 10, Legal Weights (in pounds) per Bushel of Various Commodities; Circular No. 67, Wire Gauges; Circular No. 71, Rules and Regulations Promulgated under Authority of the Federal Standard-Barrel Law; Circular No. 77, Tables of Unit Displacement of Commodities; Miscellaneous Publications No. 1, A Manual of Inspection and Information for Weights and Measures Officials; a paper on The Thermal Expansion of Molybdenum, and Technologic Paper No. 114, Portable Cubic-Foot Standard for Gas.

Miscellaneous Information Furnished.

Some information has been given regarding the measurement of humidity in the temperature range 50°-150° C., and a chart giving approximate computations has been prepared.

A number of letters have been answered giving data on expansion of materials, especially the nickel steels, concerning which there seems to be a considerable demand for information.

An investigation was made for the Post Office Department of the claims concerning a tide motor as set forth in advertising matter transmitted through the mails by a certain corporation, the object of the investigation being to give the Post Office Department a basis on which to determine whether it was permissible to send such ad-

vertising matter through the mails, under the postal laws. The bureau found that the claims made were gross exaggerations and that the motor is entirely impracticable.

During the early part of the fiscal year the Bureau cooperated with the Food Administration by furnishing lists of weights and measures officials in the various States, about 1,500 in all, so that the Food Administration could enlist the services of these officials in the conservation of food, as it was believed that this body of men, in view of their acquaintance with the methods used and the channels employed in the production of food supplies and their distribution from the producer to the consumer, could render valuable service. The Bureau prepared a circular letter to these officials explaining that cooperation with the Food Administration would be of great benefit and urging their assistance. The replies to these letters indicated that the fullest measure of cooperation and assistance would be given the Food Administration.

In view of the necessity of making efficient use of the full tonnage capacity of ships, the Bureau has been compiling information on the volume displacement of various commodities as packed for overseas shipment, to ascertain the number of pounds per cubic foot, the number of cubic feet of space required for a short ton and a long ton, and the manner in which the material is packed for shipment, so that the data might be compiled in a form readily usable. Information along this line has been furnished from time to time to various branches of the Government, as well as to private concerns. A short circular has already been prepared presenting much of this information and a more extensive publication is now nearly ready.

At the request of a representative of the inspection office of the Quartermaster's Department of the Army data were made available for the comparison of the accuracies in field service of two types of liquid-measuring pumps under consideration for purchase by the Depot Quartermaster Corps. The data furnished were derived from the extensive field inspection made about a year ago, which was recorded by the use of index cards in a manner making it possible easily to determine statistically the comparative merits in operation and the relative permanence and accuracy of the various makes concerned. This information when considered with results subsequently obtained in a test of efficacy of the filter with which the pumps are equipped for separation of water from gasoline provided adequate information on which to decide the purchase.

In connection with the purchase of a large number of prescription balances and apothecaries' weights for the medical supply depot of the Army at New York City, the Bureau was enabled, in view of the thorough study that it had given to tolerances and specifications for balances during the past several years, to render valuable assistance in the preparation of specifications with which the apparatus should comply and the tolerances that should be allowed. A considerable saving in time, which is always so important a factor in war work, was also undoubtedly effected.

Assistance was rendered the weights and measures department of the State of Massachusetts in preparing plans for rearranging and enlarging their laboratory to take care of expanding work, a representative of the Bureau being sent to Boston to inspect personally the available space and to confer with the State officials in the matter.

2. ELECTRICITY.

[Electromotive force, resistance, current, inductance, capacity, conductivity, insulation, magnetic permeability and hysteresis, radioactivity and radiocommunication, including researches on electrical units and standards, measuring instruments, and methods of measurement, and cooperation with standardising committees of technical societies, with testing laboratories, the electrical industries, public-service companies, and public-utility commissions, municipalities, and engineers upon problems of electrical standardization, including standards of adequacy, and safety of electric service.]

Scope of the Electrical Work.

One of the most important functions of the Bureau with respect to electricity and allied subjects is the establishment and maintenance of the fundamental standards upon which all measurements in these fields are based, including cooperation with similar institutions in other countries so as to secure international uniformity. This includes the intercomparison of standards and extensive research in methods of measurement and the development and improvement of subsidiary and derived standards. These standards are utilized and the results of the researches are immediately applied in the testing of reference standards and instruments for manufacturers, testing laboratories, universities, research institutions, electric utilities, utility commissions, engineering and other interests, and various agencies of the Government.

The testing of electrical instruments and apparatus is of two main classes. First, there is the standardization of reference standards and precision instruments for manufacturing and other institutions which themselves make or standardize instruments for commercial use or which conduct research work. It is through the work of such institutions that the measurements made in practice are referred back to the standards of the Bureau. Second, a limited amount of testing of commercial electrical measuring instruments, radio and photometric apparatus, magnetic materials, etc., is done, chiefly for the purpose of keeping the Bureau in touch with the needs of the industries, of developing methods, and of improving types. The greater portion of this testing is done for the Government services, and serves the double purpose of providing information to be used in formulating specifications, and of determining the quality of deliveries of materials purchased upon specifications.

The research work has mainly to do with methods of measurement, the determination of the electric and magnetic properties of materials, and the development of those phases of engineering science in which measurement plays an important rôle. Electrical, radio, and illuminating engineering interests are all served by these investigations. The Bureau also renders important service, both directly and indirectly, to manufacturing and other industries. Some of this investigational work is on the more fundamental aspects of the principles involved, so that the results may be applicable to a class of problems, rather than being limited to the one specific problem under investigation. The work in measurement of lights of different colors, and correlations of magnetic and mechanical properties of iron and steel, and study of galvanometers are examples.

The research work in radiocommunication, magnetism, radioactivity, and photometry is along lines quite similar to that in the more purely electrical measurements. Standards have been and are being developed, methods of measurement are being improved, and

important special problems of significance to the industries and in a number of cases of particular importance to the Government, are being investigated. Specific examples of the projects in hand during the past year are given in the sections below.

Special Military Work in Electrical Subjects.

During the past fiscal year opportunities for service to military departments have been so numerous both in testing and in research that the resources of the electrical division, like those of other parts of the Bureau, have been very largely devoted to such service. This has involved a greatly increased amount of work similar to that performed in ordinary times, including consultation with other departments on a large number of technical problems; opportunity has also been found to undertake somewhat extensive investigations of a few important military problems. This military work has been made possible in part by the use of special funds provided by Congress and by the military departments and in part by cutting down so far as practicable the time devoted to ordinary work which has less bearing on the war.

STANDARDS OF RESISTANCE.

(Maintenance of fundamental standards of electrical resistance, calibration and development of practical resistance standards and apparatus, testing of conductors and of conductivity of materials, galvanometer design.)

INDUCTANCE AND CAPACITY.

(Methods of measuring inductance and capacity, preservation and calibration of standards of inductance and capacity, design of apparatus involving inductance and capacity phenomena, development of formulas for computing inductance and capacity, measurement of short time intervals.)

With the exception of necessary work in routine testing, these two sections have devoted practically all their time during this year to urgent military problems of a confidential nature.

ELECTRICAL MEASURING INSTRUMENTS.

(Design and calibration of electrical instruments and appliances.)

Testing of Electrical Instruments.

This work has necessarily been considerably curtailed during the year. Preference has been given to tests for the military authorities, but the needs of others have been met so far as possible. Work of this kind is made more difficult, but at the same time more necessary by the fact that mechanical defects and errors of calibration are more frequent now than in normal times. Even the best makers of instruments have had difficulty in keeping their output up to the usual standards of accuracy.

New Deflection Potentiometer.

Some improvements in the design of deflection potentiometers have been made, and the latest type of this kind of instrument incorporating these improvements was received from the makers early in the year. The design has been simplified as compared with former instruments. This latest potentiometer has a fundamental range of 0 to 150 millivolts readable by estimation to 10 microvolts.

Instrument Transformers.

The accurate testing of instrument transformers is of increasing importance on account of their use in measuring electrical energy,

especially where it is sold in large quantities or at high voltages. Some of the State public utility commissions now require the periodic testing of instrument transformers used in the sale of electrical energy. A very considerable amount of assistance has been given to some of the State commissions and the larger central stations in designing special equipment for their laboratories for the testing of instrument transformers. Two sets of such equipment have been constructed and submitted to the Bureau for test.

Methods of Testing the Electrical Properties of Transformer Oils.

In cooperation with a committee of the American Society for Testing Materials, a comparative study is being made of disk and sphere spark gaps for testing the dielectric strength of transformer oils. A carefully prepared schedule of tests on different gaps and different spacings is being carried out in four different laboratories. This investigation has been delayed by the pressure of war work. Some progress has been made in correlating the data obtained in the Bureau's tests and those of the Vacuum Oil Company. The Westinghouse Company has made the tests but their results have not been received by the Bureau. The General Electric Company is also to make measurements for comparison with the others. It is expected that data will be obtained which will permit results obtained on one form of gap to be interpreted in terms of other forms of gaps, or possibly a uniform method of testing may be agreed upon.

Blasting Machines.

At the request of the General Engineer Depot and of the Army Ordnance Department, tests have been made of the electrical blasting machines used in firing trench mortars, mines, etc. There seems to be room for much improvement in the design of apparatus for this purpose and several experimental models have been constructed which show promise of reduction in weight and cost, and increase in reliability. Improvements have also been suggested for the indicators used to show that such machines are in working order just before firing.

Ignition in Gasoline Engines.

Investigation of problems connected with spark plugs, magnetos and other ignition devices, has been carried on by the Electrical Division in cooperation with other parts of the Bureau. Statistical records are now being kept of the plugs used in various aviation engines at the Bureau to determine their average service. These records indicate that fouling from carbon deposits is by far the most frequent trouble.

Improved porcelains, developed by the Ceramic Laboratory of the Bureau, have been put into production by at least one manufacturer and are now being tested in Liberty motors.

At the request of the Bureau of Aircraft Production oscillograms have been taken showing the performance of various types of magneto and battery ignition systems. The information contained on these oscillograph films is gradually being digested and will be incorporated in a series of reports covering various features of the operation of magnetos.

An investigation has been begun on the use of subsidiary spark gaps and condensers in various connections with ignition systems.

The phenomena appearing in such circuits are exceedingly complex but there is definite evidence that such arrangements will cause a heavily sooted plug to fire under certain conditions. There is promise of developing on this basis a practical system of great value.

Mica for Electrical Purposes.

At the request of the War Industries Board, tests have been made on a number of samples of mica to determine their suitability for use in magneto condensers. A number of magneto factories were visited in connection with this work, and the methods of testing used in the factory were studied in order to duplicate as far as possible the requirements of commercial practice. The best utilization of our mica supply is of great importance because difficulty is experienced in obtaining shipments from India, which has previously been the chief source of supply.

Printing Chronograph.

For the Bureau of Ordnance of the War Department, a printing chronograph was rebuilt so that four printed records may be made simultaneously by as many observers. This instrument is for use in securing experimental data for improved range tables, and in the timing of shrapnel fuses which are tested at the Aberdeen Proving Ground.

Velocity of Projectiles.

For several months the Bureau cooperated with the Sandy Hook and Aberdeen Proving Grounds on the problem of the rapid and accurate determination of the velocity of projectiles. A representative of the proving grounds was stationed at the Bureau, and members of the Bureau cooperated with him in the preliminary laboratory study of various methods for the measurement of velocities, accompanying him on trips to the proving ground for field trials.

The method finally decided upon is now in regular use in the testing of ammunition in this country and in France. Arrangements of the electrical circuits for the recording part of the method were worked out at the Bureau. A master direct-reading scale for this work was made at the Bureau, and in use was found to make it possible to obtain final results in 10 seconds.

MAGNETIC MEASUREMENTS.

(Measurement of magnetic properties of materials; design and calibration of magnetic instruments and appliances, including compasses; magnetic analysis.)

Bismuth Spiral for Measurement of Magnetic Fields.

In many kinds of investigational work bismuth spirals are very useful, but suitable methods of calibrating the spirals have been lacking. The development of a method and of apparatus for the calibration of these spirals, has been completed during the year and a paper on the subject has been submitted for publication. The method provides a means for placing the spiral under test in a magnetic field which is measured by means of a standard test coil and ballistic galvanometer. Suitable temperature control is also provided. Numerous precautions which must be observed both in the calibration and the use of bismuth spirals are pointed out in the paper.

Determination of Magnetic Susceptibility.

Considerable experimental work has been done on the development of a rapid method for the determination of magnetic susceptibility in routine testing. Two methods have been investigated, one using a sensitive balance for weighing the attraction of a magnetic solenoid for a sample under test, and the other a ballistic method. This work is not completed but has been laid aside for more important work arising from military needs.

Standard Magnetic Bars.

A set of bars has been prepared to serve as magnetic standards. Their magnetic homogeneity has been carefully examined and complete magnetic data determined. The magnetic properties will be redetermined from time to time as a check on their constancy.

Magnetic Analysis.

For a number of years work has been under way at the Bureau in the development of methods and apparatus for using the magnetic properties of materials as an indication of their quality and mechanical properties. During this year a paper entitled "Magnetic Analysis as a Criterion of the Quality of Steel and Steel Products" has been submitted for publication. The magnetic properties which might serve as criteria for the estimation of the mechanical fitness of steel are considered in detail and some methods of testing are described. The correlation between heat treatment and magnetic properties of high carbon steel is given, as well as many other valuable data.

The general method of "magnetic analysis" has been applied during the year to the three special problems of rifle-barrel steel, ball-bearing races, and steel cable. The plant of one of the large manufacturers of small arms was visited in connection with the study of the process of manufacture of rifle barrels and special work was undertaken with a view to the development of suitable methods of magnetic testing for this steel. Promising preliminary results have already been obtained and apparatus is now in process of construction for the testing of the steel bars used, as received from the mill.

The application of magnetic testing of ball-bearing races was undertaken in cooperation with one of the larger manufacturers of ball bearings, and in this connection efforts are being made to develop a design of testing apparatus which will be suitable for use in the factory. Some preliminary experiments in the work on steel cables have been carried out, but, as in the case of the last-mentioned investigation, have suffered serious interruption on account of the transference of men into the military service.

Magnetic Compasses.

The formulation of specifications and the development of methods of testing of compasses have received little attention in the past. During this year specifications for performance of airplane compasses and of lensatic compasses have been drawn up and submitted to the military authorities. The proposed specifications for the lensatic compasses were adopted by the Engineering Bureau of the Army Ordnance Department.

Methods of testing were developed in cooperation with the Inspection Department, Equipment Division of the Signal Corps, and

cooperation with this Department is being continued. Apparatus has been constructed for compass testing at the Bureau and is still in process of development.

Investigations have been carried out on damping liquids for air-plane compasses which have led to the adoption of kerosene instead of the alcohol and water mixture formerly used. Specifications were prepared for kerosene for such use. Experiments were also made on the methods of heat treatment and aging of magnets for compass needles and compensators.

Railway Signal Relays.

At the request of the Committee on Direct Current Relays of the Railway Signal Association, an investigation of railway signal relays has been undertaken. This is to include the development of a suitable aging process by means of which deterioration of a relay will be produced comparable with that which occurs in a long period of service. This process is to form part of a test procedure to be used in tests under the auspices of the Signal Association.

PHOTOMETRY AND ILLUMINATING ENGINEERING.

(Maintenance of photometric standards, calibration of standard lamps, development of methods of photometry, inspection and life-test of electric lamps, problems in the utilization of light.)

Trench Flares.

The exigencies of trench warfare call for the use of many special illuminants. Many of these are quick-burning flares of very high candlepower. Immense quantities of these materials are being purchased by the War Department, and no quantitative information about their performance was available. In cooperation with the Ordnance Department, measurements of candlepower, time of burning and smoke produced were made on samples obtained from different sources to find out what might reasonably be expected of each type of light. Similar measurements were made on many samples in order to improve the performance by modifying the composition and construction. The developmental work on these illuminants is largely chemical and has been handled by the Ordnance Department. The Bureau has developed methods of making the photometric tests required and has assisted the ordnance officers in initiating the work of routine inspection and testing.

Portable Acetylene Lights.

Several months were spent in a test of numerous types of portable acetylene lights with particular reference to their suitability for military use at the front. These tests were made primarily to obtain information which should serve as a basis for choice between the different types of light. It developed, however, that nearly all of them had certain defects for such use. The defects of various types were discussed with the makers and a number of modifications suggested by the bureau were made.

At the request of the Signal Corps, comparisons were also made between two types of acetylene generators for use in traveling photographic workrooms. After tests were made in the Bureau laboratories, the development of improved apparatus was taken up with the manufacturers and as a result a satisfactory outfit, much simpler than that now in use is nearly ready for production.

Photometric Tests of Field Searchlights.

This work has included field measurements and laboratory tests. The field work has been largely the measurement of illumination in the beam at various distances up to 4 miles, with particular reference to the distribution of the light from different types of searchlights and to the effect of front glasses, louvers, various reflectors, and various types of carbons. The laboratory measurements have included determinations of the intensity and distribution of the light from the arcs (without reflectors) under various conditions.

Special Problems in Illumination.

Numerous conferences on illumination problems have been held and many minor tests made for various departments of the Government. A great deal of this consultational work has been done for different sections of the Science and Research Division of the Signal Corps, for whom at various times more than thirty lamps have been standardized or measured under special conditions. Besides these a number of tests of lamps at excessive overvoltages have been made in order to determine the best condition of operation for tracing by photographic methods the course of falling bombs.

For the Field Medical Supply Depot of the Army, a collection of flashlights were tested to determine the candlepower of the lamps and the distribution of light in the beams. A comparative life test of flashlight lamps was also carried out. This included the comparison of lamps of American manufacture with a number of samples submitted by importing firms. It was found that the American lamps in general were far superior to the imported ones.

In connection with the choice of lighting fixtures for various buildings under construction for the Government, a considerable number of samples were obtained at various times, and measurements of the distribution of the light from them were made. Several sets of samples of window fabrics for use in the war zone were measured to determine their transmission.

Standard Specifications for Electric Incandescent Lamps.

Unsettled manufacturing conditions arising from the war have made necessary considerable changes in the standard efficiencies of incandescent lamps. A new (eighth) edition of Circular 13, "Standard Specifications for Electrical Incandescent Lamps," has been prepared and issued. The most important changes are (1) a small reduction in the efficiency of vacuum tungsten lamps, necessitated by unfavorable manufacturing conditions, (2) the addition of specifications for gas-filled tungsten lamps, and (3) a provision for small readjustments of efficiencies downward as well as upward at the request of the manufacturers. Previous specifications have allowed increases of efficiencies but not decreases.

Inspection and Life Testing of Lamps.

As a result of war activities, the Government's purchases of electric lamps have multiplied several fold. Orders placed during this year call for about 8,500,000 (5,350,000 large tungsten, 1,450,000 large carbon, and 1,700,000 miniature lamps), and inspection by the Bureau was requested on about 5,800,000 of these. Production has lagged behind this great increase in orders and about 2,800,000 of the above lamps were undelivered on July 1, 1918. Actual inspections

during the year, including lamps delivered on orders placed last year, approximate 3,700,000 lamps, of which about 1,100,000 were carbon and 2,600,000 tungsten. Life tests were completed on 2,015 tungsten and 559 carbon lamps. A new detail in the method of keeping records and reporting results is that samples have been marked to indicate the month of manufacture, and separate records of the product of each month at each factory have been compiled. This enables the Bureau to judge more fairly the average quality of the yearly output and also gives data which are useful as checks on current factory life-test results.

While gas-filled lamps have not been covered by the specifications in force during the year, a considerable number of them have been subjected to life tests for our information. In general they have shown a satisfactory performance.

With regard to the value of the routine inspection of lamps, it may be said that while the percentage of lamps rejected on inspection at the best factories is low (about 3 to 6 per cent), there is incontrovertible evidence that orders which are to be inspected receive special attention and that lamps which fail on inspection are applied on orders which are not to be inspected. Moreover, it is generally granted by factory men that the inspection is a continual stimulus to them to exercise all possible vigilance to keep the product up in quality.

Gas-Filled Standards of Spherical Candlepower.

Experience during the past year has shown that gas-filled lamps of special construction give very good service as standards of spherical candlepower. Following the Bureau's investigation of methods of comparing these lamps of high efficiency and large candlepower with the older standards, several groups of the newer lamps have been very carefully calibrated to serve as reference standards at the Bureau, and a large number of these lamps have been calibrated for various other laboratories during the year.

Automobile Headlight Specifications.

On account of the widely different regulations adopted by various States and cities for the control of automobile headlights, it has appeared desirable for the Bureau to make a study of this subject in the hope that it might assist in obtaining the adoption of more uniform regulations. Accordingly complete information regarding regulations which have been adopted has been collected, and samples of many devices which are intended to fulfil the requirements of the various regulations have been obtained. Measurements of the distribution of the light from many of these devices have been made.

A special committee of the Illuminating Engineering Society having been appointed to formulate specifications for head lamp devices, it appeared best for the Bureau to cooperate with this committee. Representatives were accordingly sent to assist in several road tests of such devices. As a result of these tests, general specifications covering the allowable and required intensities of head lamps have been formulated by the committee, with particular reference to a recently enacted law of New York State, and these specifications have been adopted by the Secretary of State of New York as a basis for the approval or disapproval of devices submitted to him. In case of dis-

pute as to the results of tests made under these specifications, provision is made for appeal to the Bureau.

RADIO COMMUNICATION.

(Methods of measurement at radio frequencies; design and calibration of radio instruments.)

New Radio Building and Equipment.

A new annex to the Electrical Building, which will be used by the radio section of the Bureau and also afford quarters for laboratories for the Army and Navy, has been nearly completed. A large amount of new equipment has been designed and ordered, and it is hoped that greatly improved facilities for the radio work will be available early in the coming year.

Circular on Radio Instruments and Measurements.

The theory and practice of radio communication have advanced so rapidly in the past few years that satisfactory text books are not available. The need of such text books for use in the Signal Corps training courses has been very urgent. To meet this need the Bureau has prepared a circular (No. 74) entitled "Radio Instruments and Measurements," which has met with a very favorable recognition and is now in use in the training courses mentioned. About 4,000 copies have been distributed.

Use of Closed-Coil Antennas.

For several months considerable experimental work was carried on in the field, in cooperation with officers of the Signal Corps, with closed-coil antennas or loops for transmission, reception, and direction finding. With the results of this work as a basis further study is being made of the apparatus by the Signal Corps, with a view to its practical application. In connection with this investigation of closed-coil antennas several interesting characteristics of such coils have been developed, and further studies of the theory and practical application of this type of antenna are planned.

Insulating Materials for Radio Apparatus.

An important investigation was undertaken early in the year involving the study of various kinds of insulating materials used in the construction of radio apparatus. Various properties of these materials were measured in other laboratories of the Bureau; the principal measurements made in the radio laboratory were those of phase difference and voltage properties. Preliminary results have been furnished to the War and Navy Departments and should have an important bearing on the production of radio instruments.

Miscellaneous Testing, Calibration, and Designing of Radio Instruments.

A great deal of testing and calibration work has been done during the year for various branches of the War Department, and in several instances designs of apparatus have been turned over for the use of the Signal Corps. For example, the standard variable condensers developed by the section have been adopted for use in the Signal Corps laboratories. Standard high-frequency resistance units have been constructed and supplied to the Signal Corps, and a standard inductance constructed in accordance with the design developed at

the Bureau has recently been requested for the Little Silver laboratories. It has been necessary also to supply full calibration data for all of this equipment, some of which required considerable experimental work. Many wavemeters, decimeters, condensers, resistance units, grid-leaks, vacuum tubes, and other miscellaneous pieces of equipment have been calibrated for various branches of the War Department.

A small portable decimeter for field use was designed, and several instruments of this type were calibrated for the Signal Corps after construction. A study was made of precision resistance measurements including the development of a direct reading phasemeter and decimeter. Extensive experiments were made upon the shielding effects of wire cages. Equipment was developed and constructed for producing high voltages, long and short waves, and for other special requirements of measurement work. An investigation of crystal detectors was undertaken and is still in progress.

Vacuum-tube Apparatus.

Vacuum-tube apparatus is finding a rapidly increasing application, and considerable attention has been given to the study of such tubes at the Bureau during the past year. Methods for measuring the characteristics of tubes have been developed and other experimental work is under way.

A compilation of published information regarding the theory and operation of these tubes as used in radiotelegraphy, radiotelephony, transcontinental telephony, and in laboratory measurements, was prepared by a member of the Bureau and published in book form by the Signal Corps, under the title "Vacuum Tubes—Theory and Use." It includes the general theory and description of the tubes, the mathematical theory of their operation, results of experimental research with the tubes, their use in radio reception, miscellaneous tubes and uses, and a bibliography. This book has been widely distributed among officers of the Army and Navy, and among radio engineers and others directly interested in the use of these instruments.

SOUND RANGING.

(In normal times Section 7 is devoted to a study of electrolysis and related problems. During the past year nearly all of the staff of the section have been working on various military problems, especially sound ranging.)

Sound Ranging.

A large amount of time has been given to the study of means of locating batteries and the development of new equipment for this purpose. Two members of the Bureau were commissioned during the year and sent abroad to put into use at the front the equipment developed at the Bureau. One of them, Capt. Ernest Weibel, was killed during the German offensive of March, 1918. Capt. Weibel's death interfered seriously with the plans which had been made for field trials of the equipment, but the work has been vigorously prosecuted at the Bureau, and field tests have been made at the proving ground at Winthrop, Md. The apparatus which has been developed has some features in which it excels any other equipment in use, and it is expected that sets will soon be put into use in France.

ELECTROCHEMISTRY.

(Electrochemical problems, particularly those involved in electrical batteries and electrical measurements.)

Electric Batteries.

The need of the development of specifications and methods of testing for electric batteries has long been recognized; but facilities have not been available to undertake this work. The needs of the military departments have recently become so urgent that the study of batteries has been undertaken.

Attention was given first to dry cells, and all the available information on the subject was abstracted and classified. Letters were sent to the leading manufacturers asking for information, and their replies were also abstracted and classified. Laboratory measurements on various types of dry cells were made under various conditions, and an examination of the structure of the cells was also made. In order to become familiar with the process of manufacturing cells, members of the staff visited a considerable number of factories.

As a result of this work, a circular has been prepared for publication. This includes information regarding the various sizes and kinds of dry cells, the general electrochemical principles involved, and the electrical performance of such cells. A set of proposed specifications for dry cells intended for Government use is also included. This circular has been sent to the leading manufacturers for criticism, and after discussion with manufacturers and users of the cells, will be published.

A large amount of chemical work has been done on dry cells, including the development of methods of determining the available oxygen, the total sal ammoniac, moisture, and chlorine, and also analytical methods of finding certain impurities which are frequently present and reduce the life of the cell. No chemical process for determining the difference between a good cell and a poor one has been discovered; but the chemical results run parallel to the electrical tests in that cells which are deficient in available oxygen or sal ammoniac, show comparatively poor electrical performance. It has been found that cells of the same make often differ greatly in composition, and in some cases where such variations of composition occur, the cells deteriorate very rapidly on open circuit.

On storage batteries, work is just being begun. A few plates have been analyzed, and attention is being given to the development of special analytical methods which are required for the electrolyte, because minute quantities of certain impurities in the electrolyte seriously affect the performance of the cells. Experiments have also been made on containers, particularly the celluloid used in some military batteries. Celluloid containing a strong solution of sulphuric acid has been found to liberate nitric acid which is detrimental to the storage battery. A considerable number of storage batteries are being received for test and electrical equipment for more extensive tests of these batteries is being assembled.

Two special reports have been prepared. One of these dealt with the question of obtaining American cells to replace the Hellsen cells which the British Government was purchasing from Scandinavia. This problem involved fitting a battery which would meet certain

voltage and current requirements into a limited space, provided for it in submarine mines. The second report was submitted to the Food Administration on the use of wheat flour in batteries. Wheat flour has long been used by manufacturers in the paste which is contained in the bag-type cells, and it was believed that an appreciable saving of wheat might be made by substituting other kinds of flour.

Attention has also been given to the construction of special cells to give long shelf life. A small number of cells were constructed at the Bureau for the Signal Corps for this purpose, and were found to give an unusually long life. The Signal Corps is taking steps to patent the process used in order that the Government may have free use of it for military purposes.

At the request of the military authorities, the development of a galvanic pile which would give comparatively high voltage and small capacity in a limited space has been undertaken. Three types of piles have been under development, one using lead peroxide, another manganese dioxide, and a third a simple pile of zinc and copper.

Among the batteries which have been tested, are the following kinds: Paper-lined dry cells, bag-type cells, silver-chloride cells, reserve cells, special batteries for the Ordnance Department of the Navy, special batteries for radio work, carbon-steel cells, flash-light batteries, alkali track batteries, alkali signal batteries, acid storage batteries, alkali storage batteries, and dry storage batteries. Tests have been made for the Panama Canal, the Bureau of Ordnance of the Navy Department, Naval Torpedo Station, Signal Corps, Engineer Corps, Medical Corps of the Army, the Depot Quartermaster and the Ordnance Bureau of the War Department. The total number of batteries which have been tested during the year at the Bureau is 450, while 3,000 have been tested at the military storehouses.

Miscellaneous Electrochemical Work.

Minor problems in electrochemistry have included the platinizing of electrodes for work in conductivity of electrolytes, the plating of radio detector crystals, the preparation of impregnated paper for spark recorders, testing the continuity of the enamel of large iron kettles used by the chemists of the Gas Defense Service, and assistance given to the Chemical Division in developing a new process for cleaning gun barrels.

RADIOACTIVITY AND X-RAY MEASUREMENTS.

(Methods of measurement of radio-active materials and phenomena, standardization of radium, radium preparations, and similar materials; development of X-ray equipment.)

Luminous Materials.

Both the apparatus for and the technique of the measurement of the brightness of self-luminous materials have been much improved during the year. The fifty preparations under study in June, 1917, and a few others obtained since then have been measured at intervals. The conclusions drawn from these measurements have been made available to the military authorities interested in such materials.

These materials are largely used for airplane instrument dials. Since little information regarding the brightness needed for satisfactory legibility of dials was available, the Bureau arranged to have

a number of dials of various known brightnesses examined under service conditions of illumination by members of the air service of the United States and allied nations. A better idea of the brightness desired under different conditions was thus obtained. The variation of the legibility with the size and brightness of the characters has also been studied.

The conclusions thus reached have been used, and passed on to those interested, as rapidly as obtained and are now being collated in a series of recommended specifications for luminous articles.

Regarding the permanence of luminous material under service conditions little was known. It was believed that in general, an exposure to direct sunlight markedly decreased the brilliance of applied material. Observations made during the past winter have, however, shown no very marked decrease in brightness, due to an exposure either to the sun or to a mercury arc. The dials used in this test were of low brightness. Similar tests upon other dials will be begun at once.

Specifications for luminous markings upon airplane dials have been recommended to the Signal Corps, United States Army, the Bureau of Steam Engineering, United States Navy, and informally to other departments of the Government. These specifications have been in the main adopted by the Signal Corps.

Since September, 1917, the brightness of a large number of dials has been measured for the Science and Research Division of the Signal Corps, United States Army, (recently transferred to the Bureau of Aircraft Production), as a basis for the awarding of contracts for the illumination of airplane instruments.

At the request of the Inspection Department of the Signal Corps, the Bureau has prepared and standardized equipment for factory inspection of dials, and has instructed inspectors in the details of factory testing. Since this equipment has been in use, brighter dials have been secured.

Since the first of January, 1918, a percentage of the luminous dials accepted by the Inspection Department has regularly been sent to the Bureau for careful measurement of brightness. Certain of the dials have been submitted to a life test, and a number of compass cards have been measured both dry and submerged in kerosene. The effect of continued immersion in kerosene also has been studied. The cause of some of the changes observed on immersion is still not clear; the study is being continued.

An investigation of methods for applying luminous materials to dials and other objects was undertaken late in November. Luminous materials were obtained from the different manufacturers and were applied to dials by means of various adhesives and methods. The various characteristics of the different adhesives and methods were noted and the brightness of the finished product was measured. The problem was studied from many angles and a method of application that is more efficient than any now in use was developed.

The following reports have been issued: "Self-Luminous Materials Containing Radioactive Excitants," "Notes and Suggestions Concerning Luminous Instruments," "Self-Luminous Materials—Brief Notes Covering a Few Points of Practical Importance." All of these were typewritten reports issued in editions of a few copies

each and have been distributed to those Government departments that have appeared to be most interested.

Throughout this work the cooperation of the manufacturers and users of these materials has been most gratifying and of great assistance to the Bureau.

Standard Radium Solutions.

Incidental observations indicate that the standard radium solutions made up in the summer of 1914 have not changed by as much as 1 per cent since they were prepared.

During the year, 100 cubic centimeters of the dilute solution (10⁻⁴ gram of radium per cubic centimeter of solution) were furnished to McMaster University, Canada.

Radium Emanation Work.

The work involving radium emanation measurements is mainly the examination of materials suspected of radioactivity, of waters (natural and artificial), and of therapeutic preparations. No steps have been taken to encourage the development of this branch of the work, because all the facilities available could be used to advantage in more urgent lines.

During the year 1 activator has been tested, the study of 4 others has been completed, and 5 radium determinations have been made; 2 of the latter were for the Department of Agriculture.

Gamma-Ray Measurements of Radium.

In July, 1917, the Bureau of Mines donated to the Bureau the tube containing about 49 milligrams of radium which was loaned to the Bureau of December, 1916, and also a second tube containing about 91 milligrams. Further than this, no change has been made in the equipment for this work.

Early in 1918 the rate of receipt of specimens for gamma-ray measurement decreased markedly and has remained low. The amount of material for certification to physicians is now very small on account of war conditions.

During the year 177 specimens, containing a total of 5,376 milligrams, have been measured. Of these, 50 specimens containing a total of 1,009 milligrams were certified for foreign shipment. These were distributed as follows:

Country.	Number.	Milligram radium
France.....	24	651.55
Japan.....	11	207.19
Spain.....	12	129.55
India.....	3	20.38

Most of the radium certified for export to France is said to be for the use of the French Government in the manufacture of self-luminous material for war purposes. Two tubes (74.1 milligrams) were certified to the American Red Cross Society; it was understood that these were intended for the Russian Government.

X-Rays.

The X-ray equipment purchased in the spring of 1917 was installed in July. The apparatus has been studied in some detail, subsidiary equipment has been constructed and purchased, the routine testing of protective materials has been established, and miscellaneous radiographs have been taken for the purpose of obtaining information regarding the internal structure of materials and articles.

In its endeavor to secure the domestic manufacture of improved protective materials, the Bureau met with splendid cooperation on the part of the manufacturers. As a result, one can now obtain commercial material which gives nearly twice as much protection per unit thickness as was given by material obtainable a year ago. (Improvement in glass reaches 80 per cent, in rubber 100 per cent.) A note on this work has been published in the American Journal of Roentgenology, and a more detailed paper has been prepared for the same journal.

A study of the technique for the radiographic detection of flaws in aluminum and in steel is still in progress.

PUBLIC-UTILITY STANDARDS.

Public-Utility Investigations.

A large and important field of work, including more of engineering and field work than most of the electrical work so far described, is concerned with the various public utilities, particularly electric light and power, gas, street railway, and telephone companies. The work includes (1) scientific and engineering research, (2) the study of public-relations questions, (3) the preparation of specifications regarding the quality of public-utility service, (4) methods of testing and inspection employed by municipalities and commissions, (5) safety rules for use by the utility companies to safeguard their employees and the public, and (6) the collection and distribution of information by published papers and through correspondence.

This work is a natural outgrowth of the research and testing work done by the Bureau of Standards for the public-utility companies for several years. The testing of electrical instruments and meters, of gas lamps and the standards employed in measuring the candle-power and heating value of gas, the life testing of electric lamps, the testing of instruments used in telephone work, research on electrolysis mitigation, and similar investigations and tests connected with the public utilities have all involved to a greater or less degree questions of standards of service in the various public utilities. The bureau has gradually accumulated a considerable amount of information on these questions and has been able to contribute materially to the establishment of standards of quality of service in several of these services. Furthermore, it has promoted with marked success the practice of settling disputed questions in this field on the basis of sound engineering and economic principles and of cooperation between interests rather than by legal controversy, and in so doing the bureau has attained an enviable position as an impartial mediator in such questions. Consequently, during the past year, when abnormal conditions have given rise to many cases in which readjustment of service standards or of rates has been called for, the public-utility staff of the bureau has been called upon for an im-

possible amount of work. The opportunities for serving the public have been great and good service has been rendered. The provision by Congress of additional funds for this work by a special appropriation has made possible considerable additions to the staff toward the close of the year, and it is hoped that even more may be accomplished during the year. The work of the following sections is largely in connection with public-utility problems.

Relation of the Bureau to Municipalities and Public-Service Commissions.

In many States the public-service commissions have set standards of service, and the Bureau has cooperated with most of those that have done so. In other States the railroad or public-service commissions have taken no action in the matter, although having authority to do so. Again, in some States there are no public-service commissions to issue regulations or to inspect the quality and safety of the service rendered by the various utilities. In any case the cities and towns must look after their own interests, in whole or in part, and frequently have taken up such matters very successfully. Even where there are well-equipped and active State commissions, which have adopted rules and are ready to hear complaints regarding rates or service, a very large responsibility rests upon the municipalities. Few State commissions will ever be likely to have a force of engineers and inspectors large enough to enable them to take the initiative in every case and relieve the municipalities of all the responsibility. On the contrary, if the municipalities are active and enterprising in their own behalf, and if the larger ones have well-equipped public-utility departments which can prepare the city's complaints or requests and take them up to the State commissions for hearing and adjudication, the State commissions will be better able to serve all the municipalities of the State, and the municipalities will enjoy in large measure the advantages as well as the responsibilities of home rule without its greatest disadvantages.

But for most cities and many commissions it is a difficult matter to judge the quality of service rendered by its utilities. The studies made by the Bureau are a great help in this connection, but much remains to be done. It will conduce to fairness and a good understanding to have the subject studied further and to have specifications as definite and complete as possible made available for all branches of public-utility service.

Obviously, it will never be practicable for any State commission or city to handle these questions alone. Though they possess large and able engineering staffs or employ specialists for each separate problem, the question of what is good service or whether the service in any given case is adequate, safe, and satisfactory can be settled only by reference to what is done under similar circumstances elsewhere in the country. In other words, standards of good practice and good service are largely determined by general experience and should be studied comparatively, using the experience of the entire country. The Bureau has been doing this for several years, and although it has not been able to do as much as it would have liked to do, it has done enough to demonstrate the practicability and acceptability of the method. The success and approval which the work has met so far fully justify its greater development.

GAS ENGINEERING.

(Standards of gas service; efficiency and economy of manufacture and distribution of gas; studies of gas utilization; by-product fuel processes and related tests.)

Gas-Service Standards.

During this year the Bureau has participated in important cases involving adjustment of standards for gas service before the New Jersey Board of Public-Utility Commissioners and before the First District Public-Service Commission of New York. A report was also made to the Indiana Public-Service Commission on the revision of standards for gas service contemplated for that State, and comments have been given to the Oregon Public-Service Commission on a petition relating to a change of standards in Portland, Oreg.

In the city of Cleveland assistance was given in establishing a testing laboratory, in calibrating equipment for it, and in instructing the chemists who were to carry on the routine testing. This work also included a very brief consideration of the adequacy of the natural-gas supply. At the request of the Railroad Commission of Georgia a study of gas-service conditions in Atlanta was made. It developed that the principal cause of dissatisfaction with the service was a shortage of oil for the manufacture of water gas. The Bureau's report was accepted by the State commission as the basis for its decision in this case.

The shortage of supplies of oil has led to the suggestion that changes should be made in standards for gas quality, and it has been suggested to the Fuel Administration that all existing standards of heating value be abrogated and a uniform requirement of 528 British thermal units per cubic foot should be adopted. The Bureau, in common with most State and city authorities, has felt that this radical change is of doubtful wisdom and has given considerable attention to alternative methods of meeting the situation without such a general reduction in the quality of all manufactured gas.

This and numerous other cases in which readjustments of standards of quality have arisen during the year have given rise to opportunity for a very extensive application of the results of the experimental work carried out last year upon the relative usefulness of different qualities of gas.

Natural-Gas Service.

As mentioned above, some attention was given to natural-gas service in the city of Cleveland. The same question was raised with regard to the supply of natural gas for the city of Louisville, and this has led to an extensive field investigation on the supply of natural gas available for this territory. Data for a preliminary report on this subject have been gathered and the cooperation of various agencies is assured in continuing this work.

Gas Lighting.

As partial reports upon the investigation of relative usefulness of different qualities of gas, Technologic Paper No. 99, entitled "Gas Mantle Lighting Conditions in Ten Large Cities in the United States," has been issued and Technologic Paper No. 110, entitled "The Influence of Quality of Gas and Other Factors Upon the Efficiency of Gas Mantle Lamps," is in press. The work reported in the latter paper gave results not in accord with the general opinion that

gases of lower heating value are much more efficiently used. The margin of advantage in utilization of such "leaner" gases is small in mantle lamps, and consequently the heating value is an excellent measure of the usefulness of the gas for lighting.

Proposed National Gas Safety Code.

The Gas Safety Code has been advanced very little during this year, but a first draft of part 2 of the code has been prepared in manuscript form. A preliminary report of tests of flexible tubing has been prepared and sent out for comment. The results obtained in these tests enabled the Bureau to render assistance to the city of New York in connection with a proposed ordinance fixing standards for the construction of flexible gas tubing. As a result the city avoided the adoption of a very drastic and undesirable form of ordinance.

Economic Importance of the National Gas Safety Code.

The Bureau of Standards in carrying out this investigation desires to serve as a national coordinating agency to the end that the resulting code will be acceptable and adequate, not only from the standpoint of the user of gas but also of the casualty and fire-insurance interests, the gas companies and their employees, and the gas-appliance manufacturing and selling interests.

The need and value of such a code is so great that the various national organizations dealing with subjects covered by the code have appointed special committees and expert representatives to assist in the investigation. The following organizations have cooperated in this work: The American Gas Institute, the National Commercial Gas Association, the Natural Gas Association of America, the National Fire Protection Association, the American Institute of Architects, the National Safety Council, and the National Association of Master Plumbers. In order that the Bureau may have the fullest information on every detail of the subjects discussed, the American Gas Institute has appointed 12 committees, four in each of the three principal sections of the country—East, Middle West, and Far West. One committee in each district is intrusted with the work bearing upon one of the principal phases of the investigation.

It has been estimated that avoidable accidents, due to ignorance, carelessness, or faulty installation result in the loss each year of hundreds of lives and the destruction of property of large aggregate value. It may reasonably be expected that many of these losses will be eliminated when the code has been completed and adopted throughout the country, both because of the official enforcement of the code and because of its educational value to gas fitters, appliance manufacturers, utility operators, and the general public.

The code will also serve to unify practice in gas installations and gas-company operation throughout the country, and it is anticipated that much-needed reforms will result. This uniformity of practice will not only tend to greater safety, but will also contribute to higher efficiency. In many cases differences between the insurance and gas-company officials can be settled by reference to the code, and thus more harmonious cooperation of the two parties can be expected. Already several important instances have been referred to the Bureau for consideration with a view to the settlement of differences in in-

surance-inspection practices or questions as to the magnitude of the fire hazard in certain types of gas installations. In this field the services of a recognized national authority are essential in order to standardize the practices and to make generally available the benefit of experience obtained in individual localities. The effort of the Bureau has therefore been directed not only to the preparation of the code but to the collection of such information as will enable it to serve as a national coordinating agency in this field.

Toluol Investigations.

Toluol has been required in large quantities for military use, and manufactured gas is one of the most readily available sources. The necessity of removing the toluol and benzol from gas has raised many questions with regard to the readjustment of standards and of the financial arrangements for carrying on this operation. Early in the year a conference to consider these problems was held at the Bureau and a committee representing State, city, and gas-company interests was organized. This committee met on two occasions for conference at the Bureau.

A report entitled "Recovery of Light Oils and the Refining of Toluol" was prepared, and after submission to the committee mentioned was circulated in mimeographed form and later reprinted in several journals. Another article on "Toluol Recovery and Standards for Gas Service" has also been published in various gas journals. There has been a very large demand for both of these papers, and a report to include both of them is being prepared.

Representatives of the Bureau have given a great deal of time in conference with the Ordnance Department with regard to contracts for the construction and operation of toluol plants in connection with city gas works.

Balloon-Gas Manual.

At the request of the Bureau of Steam Engineering of the Navy Department, a manual including a description of methods for the generation, handling, storage, and use of hydrogen for balloons and dirigibles was prepared. This manual is used for instructing the aviation personnel and as a guide in the operation and care of the balloon equipment.

Coke-Oven Investigations.

The seriousness of the fuel situation has lent particular importance to several investigations of fuel possibilities. It has been generally considered that only a small proportion of the coal deposits of the country could be used for coking, and consequently this coking coal has been hauled long distances to sections where large supplies of "noncoking" coals are available. New processes of coking have been proposed which would remedy this difficulty by utilizing the so-called "noncoking" coals. A comprehensive investigation of one of these processes was ordered by the President and carried out at the plant in Dover, Ohio, by the Bureau with the cooperation of the Bureau of Mines and the Geological Survey. The test was the most extensive ever conducted on a coke-oven process. More than 40 Government and company representatives participated in the work, which continued 24 hours a day for a period of 17 days. The results obtained in general supported the claims of the pro-

motors of the process, but final conclusions must await further tests to be made with more complete equipment in operation.

As an outgrowth of this investigation the Bureau has also had opportunity to make measurements on ovens of other types and has been asked to make a test of a different type plant to cover approximately the same ground, but more briefly than was done in the very elaborate tests first mentioned.

ELECTRICAL SERVICE STANDARDS.

(Standards of electric service; efficiency and economy of operation of power plants in the generation and distribution of electricity; street-lighting systems; central steam and hot-water heating problems.)

Standards for Electric Service.

For several years the Bureau has been studying the questions of specifications for electric light and power service, and the requirements that should be made by municipalities or by State public-service commissions of the public-utility corporations engaged in furnishing such service. This study was published last year as Circular No. 56, Standards for Electric Service.

In addition to proposed State rules and specifications for acceptance of types of meters, the circular contains three regulatory ordinances, suggested for cities of various sizes, descriptions of commissions standardizing laboratories, and a complete and exhaustive digest of State rules and of ordinances in force in various cities. The demand for this circular has been large, and it is gratifying to note that the rules, specifications, and ordinances proposed have been made the basis for State rules and city ordinances in many instances.

Even before the circular was published a few states had revised their electric service rules, and an appendix was added to include the new material. Since its publication, several new commissions have been established, the functions of old commissions changed and service rules have been revised in three States. The new laws and revised rules have been collected and are ready for inclusion in a new edition of the circular, for which the material is about half completed.

In all this work the Bureau has profited by the cordial cooperation of public-service commissions, municipalities, and public-service corporations, the National Electric Light Association, and the Association of Edison Illuminating Companies.

Standards for Street-Lighting Service.

For a year or more the Bureau was engaged in a study of street lighting in its technical and engineering aspects, with particular reference to the requirements that should be put into contracts between municipalities and public-service corporations for furnishing gas and electric street lighting. A number of municipal and private plants were inspected, photometric measurements made, and conferences held with managers and illuminating engineers.

The Bureau was receiving the hearty cooperation of municipalities and lighting companies, but the war has necessitated a discontinuance of much of the work on the part of the Bureau, and public-utility companies also find themselves unable to cooperate as fully as they would like to do. A special committee of the Edison Association of Illuminating Companies on street lighting will resume its cooperation with the Bureau at a later date.

The manuscript of a circular on "Standards for Street-Lighting Service" is partly completed. The scope and completeness of this study of street lighting are indicated by the following proposed table of contents: The purpose and problem of street lighting; the measurement and distribution of light and illumination in street lighting; lamps and accessories used in street lighting; general principles governing the design of a street-lighting system; description of typical street-lighting systems; the economics of street-lighting systems; discussion of contracts for street-lighting service; suggested street-lighting contracts; statistical appendixes.

No very active work has been done on the circular during the past fiscal year, but the digest of the literature has been kept up, new contracts obtained and additional data accumulated. Early in the year measurements were made on two types of street arc lamps to determine the distribution of the light and the variation of the candlepower and efficiency with current. This is part of an extensive program of such measurements which have been planned in order that first-hand information may be available for use in the circular.

As in the case of standards for electric service the Bureau seeks, while representing the public interest, to get the utilities' point of view also, and the study of street lighting will not be published until full discussion and cooperation can be had from public-utility corporations, technical societies, municipalities, and other interested parties.

Standards for Heating Service.

At the request of the Public Service Commission of Indiana, a study of hot-water heating service was begun and a representative of the Bureau spent about three weeks during February in Ohio, Indiana, and Illinois, visiting hot-water heating plants and conferring with their engineers. A proposed set of rules for heating service was formulated by the Bureau, and after public hearing on the matter these rules were adopted by the Indiana commission substantially as recommended. The manuscript of a circular on heating service is in preparation, and the National District Heating Association has appointed a special committee to cooperate in its completion.

ELECTRICAL SAFETY ENGINEERING.

(Study of means of reducing hazard to life and property arising from the use of electricity, in particular the development and application of the National Electrical Safety Code, and other safety codes.)

National Electrical Safety Code.

The Bureau has been engaged for 5 years in a study of the life hazard in electrical practice and in the preparation and application of the National Electrical Safety Code. In this work it has had the cooperation and assistance of a large number of engineers, many of whom are connected with the electrical operating and manufacturing companies, others being engineers and inspectors of State commissions, municipalities, and insurance underwriters. The various national associations connected with the electrical industry have also cooperated effectively in this work. The importance of having a national code uniform in all the States is realized to be quite as great for accident-prevention rules as for fire-prevention rules, and the advantage of having such a code prepared and presented by a na-

tional agency that can study the subject thoroughly and consult all the interests affected is obvious.

The Safety Code consists of four principal parts, as follows:

1. Rules for the installation and maintenance of machinery, switchboards, and wire in central stations and substations,
2. Rules for the construction and maintenance of overhead and underground lines for the transmission and distribution of electrical energy and intelligence.
3. Rules for the installation and maintenance of electrical apparatus and wiring in factories, residences, and wherever electricity is utilized for light, heat, or power.
4. Rules to be observed by operators in working on or near electrical machines or lines.

This code does not include the matter covered by the Underwriters' Electrical Code, but it is parallel to the latter and consistent with it.

The code is intended to be adopted by State industrial and public-service commissions and municipalities and to be complied with by public-service and industrial corporations. It is also intended to be adopted voluntarily by electrical interests when the code has not been adopted by any administrative body having jurisdiction in their district.

The Bureau's thorough study of the diverse conditions under which electricity is generated, distributed, and utilized, and of the effect of the rules on operating and construction costs, has secured a code which involves no unreasonable expense, but in general assures an adequate measure of safety and a useful standardization of practice. The large number of conferences held in all parts of the country for discussion of preliminary drafts of the code aided largely in its development to the point where it was possible to recommend it for general use throughout the country. The varying conditions in different geographical sections, and in thickly and thinly populated districts, have been given careful attention.

The code was published originally in two installments for examination and criticism; the operating rules were published in August, 1914, and revised in May, 1915; the construction rules were published in April, 1915. Both operating and construction rules, again revised after a general conference of all interests in Chicago in the spring of 1916, were combined in a single volume, Circular No. 54, which was published in November, 1916, with a recommendation for actual field trial.

It has been the intent of the Bureau, as well as the desire of all branches of the industry, that the rules should be revised and extended as experience in their use and the progress of the electrical industry shows revision and amplification to be to the public advantage. The present edition of Circular No. 54 has been exhausted and a revision is now under way which will be completed before reprinting the circular. In this revision only minor changes in subject matter have been made, but there will be considerable changes in form with a view to making the code more concise and more convenient for reference. For this purpose the rules will be separated and published in one volume supplemented by separate volumes, one giving explanations of the rules and examples of their application and another engineering data which have been worked out in connection with the development of the code.

Engineering and Experimental Work in Connection with the Safety Code.

Considerable work has been done on engineering data for the construction of outdoor electrical lines, especially with reference to sags of overhead conductors. Sags have been computed for temperatures other than those used in the original published tables, and steel wires and cables have also been considered. An article on the latter subject has been prepared for publication in the *Electrical World*.

Experiments for determining the wind pressure upon overhead wires and the shielding effect of wires upon others where they are closely grouped have been carried out. Measurements of the pressure upon models set up in the wind tunnel have been made and will be supplemented by experiments in the open air, for which apparatus has been constructed and mounted upon the roof of the Electrical Building. The results already obtained show that there is a definite shielding effect when two or more wires lie very nearly in the plane parallel to the wind velocity. With regard to the magnitude of this shielding effect it is desired to obtain the measurements in the open air before reaching final conclusions, since it is possible that the limitations of the wind tunnel may have an effect upon the pressure.

National Electrical Safety Code in Practical Use.

The code has now been adopted in one form or another, in part or in whole, by some 20 administrative bodies, and many others have taken favorable action upon it, such as the issuance of bulletins recommending the application of the code. In a few States its application has been made mandatory, notably in Pennsylvania, Wisconsin, and Montana. The code is also being used by the inspection departments of many cities and boards of underwriters. It is being used as a basis for a merit-rating schedule by casualty interests just as the Underwriters' Electrical Code has been used by the fire underwriters for some years. Such schedule ratings should result in emphasizing both the merits and demerits of particular installations from the safety standpoint, and tend to reduce accidents by proper financial recognition of each improvement made.

The code is also being voluntarily applied by a large number of utilities and industrial concerns in their own practice. It is receiving the general approval of all these interests as rapidly as its usefulness is becoming recognized, and its advantages are seen to be greater than any minor present inconvenience which its introduction may cause. It is becoming generally understood that the stability in electrical practice provided by such a national standard also conduces greatly toward the general economy, the necessity for which is becoming emphasized during this period of national stress.

Travel and Conferences for Explanation, Application, and Development of the Code.

Since some 80 State administrative bodies and many cities have electrical departments, it is desirable to send engineers frequently to different parts of the country to assist and cooperate with officials who are considering the adoption of the Safety Code, or, as sometimes occurs, are considering the adoption of other electrical safety rules prepared locally. During the past year a considerable part of the

time of the most competent engineers engaged in the safety work has been devoted to travel and consultation with State and city authorities and others concerned. Thirty-nine State commissions have been visited and in some cases considerable time has been spent in assisting these commissions to reconcile the views of opposing interests. The code as already formulated has met with gratifying success as serving as a basis for agreement in such cases.

Scope and Application of the Electrical Safety Code.

To aid in presenting the Safety Code in cases where conference is not possible with the limited staff of the Bureau, and to assist in explaining the intended application of the code, a publication has been issued entitled "The Scope and Application of the National Electrical Safety Code." In this are included brief summaries of the different parts of the code, reasons for the character of treatment employed, some discussion of the measures taken to secure adequacy and reasonableness, and some recommendations for the method of conducting inspections of installations to secure compliance with the Safety Code provisions. The publication also contains descriptions of a number of typical accidents, repetition of which would largely be prevented by observation of the National Safety Code rules for construction and operation.

An index to the code has also been published.

Use of the Code in Educational Institutions.

A special effort has been made during the year to bring the code to the attention of technical schools, and as a result, a number of engineering colleges have decided to make use of the code in their courses during the next college year. Twenty-five schools will use the code as a part of the required work in electrical engineering, and a number of others will use it as a reference. It is believed that this application of the code will have an important effect in the future development of electrical practice through its influence in inculcating safety ideas among the new generation of engineers.

Electrical Protection for Householders.

The Bureau has conducted a study of electrical hazards in the household and the means of reducing them to a minimum. The results have been incorporated in an illustrated electrical chapter of a circular on Safety for the Household (Circular No. 75), which has been issued during the year. In this study the cooperation and criticisms of lighting utilities and underwriters have been received, and the publication is in popular language, calculated to appeal to the understanding and interest of school children as well as to the intelligent householder.

General Industrial Safety Standards.

As a result of the work of the Electrical Safety Code and the numerous points of contact thus established with State and other authorities interested in safety work, the Bureau has been called upon to serve as a coordinating agency in promoting the adoption of uniform safety requirements in other than electrical lines.

Early in the year the United States Employees' Compensation Commission undertook a general inspection of Federal establishments from the safety standpoint. The National Electrical Safety

Code was utilized as a standard of reference in this work. Later safety engineers were appointed in the several navy yards and arsenals, and conferences of these safety engineers were held for the purpose of formulating definite safety standards for application in the Federal establishments. Representatives of the Bureau were invited to attend these conferences and the Bureau was later asked to undertake the revision and codification of the tentative rules covering mechanical safety. The National Electrical Safety Code was adopted as a standard for electrical construction and installation. The Bureau has revised the standards for mechanical safety, and the work has been largely completed, except with respect to goggles and eye protection.

The need for carrying out work of this kind upon a larger scale became, at once evident, and the Bureau has now undertaken a study of all available rules covering mechanical safety, with the idea of preparing a set of codes, similar to the Electrical Safety Code, which will be available for the use of State commissions and other administrative bodies concerned with the application of such rules. Steps have been taken to cooperate with State industrial commissions, insurance interests, and technical societies in this work, as well as with other Government bureaus, such as the Working Conditions Service of the Department of Labor. A large field is opened up by this work.

ELECTROLYSIS PREVENTION.

(Study of the effects of stray electric currents and development and application of methods of reducing damage resulting from them.)

Electrolysis Problem Among Public-Utilities.

The majority of the street railways of the country are operated on the single overhead-trolley plan, with the electric current flowing into the rails through the car wheels, after it has passed through the car motors. The current then flows back to the generating station or substation by way of the tracks and earth, some of it, however, often flowing through underground gas and water pipes and the lead sheaths of underground telephone and electric-light cables, and sometimes through reinforced concrete structures. The earth conducts electricity by virtue of its moisture and the salts dissolved in it, which render it an electrolyte. Hence, when the electric current flows away from iron pipes or lead-cable sheaths, it carries away iron or lead by electrolytic action, and this in time corrodes the pipes and shortens their useful life and sometimes completely destroys them in a relatively short time. The property damage caused by these earth currents when they are considerable, affects to a greater or less degree all the public utilities.

The trouble is the more serious in places where the soil has a greater conductivity than usual, and where the conductance of the tracks is small in proportion to the current, and the distance the current travels back to the stations is relatively great. Many remedies have been proposed and tried, but no standard practice for the handling of the return current has ever been agreed upon in this country. As the electric railways have been extended and traffic has become heavier, the volume of current handled has increased very greatly, and the resulting destructive effects, which are cumulative with time, have become increasingly evident. In some cases litiga-

tion has resulted between the pipe-owning companies suffering damage and the railway companies whose current causes the trouble. But although the courts have considered the question of legal responsibility, these cases did very little to prevent the trouble in an effective and economical manner.

Economic Importance of the Electrolysis Problem.

The subject of electrolysis of underground pipes, cables, and other metal structures is one which has been given more attention in recent years than formerly, but it still does not receive the attention in many quarters that its importance deserves. When one considers the enormous value of the pipe and cable properties buried in the streets of cities and forming in many cases transmission networks between cities throughout the country, and considering further that there are very few water, gas, or lead-cable systems which are not more or less subject at some points to electrolytic damage from stray currents, it is possible to form a better judgment of the practical importance of this subject. The water and gas pipe systems of this country alone have an aggregate value at the present time in excess of a billion of dollars, and in addition to this there is a vast extent of underground lead-cable systems belonging to telephone and electric power companies and to municipalities. In addition to these vast properties in the earth, a considerable part of which may be more or less subject to electrolytic damage, there are possibilities of trouble in the case of bridge structures, portions of steel frame buildings, and piers, which are occasionally exposed to damage from this source.

While the total losses due to shortening of the life of underground pipes and cables must be considerable, such loss does not by any means represent the total annual damage due directly to electrolysis. It is well known that the annual loss due to leakage of water and gas from distribution systems is very great. It is true that only a part and probably a small part of the total leakage is due solely to electrolysis, but it is only necessary to assume that a few per cent of the total is due to the more rapid developments of leaks caused by electrolysis in order to make the total loss resulting from this cause run well into the millions annually.

In making a valuation of underground pipe systems, as, for example, in the case of a valuation to be used as the basis for a transfer of property or for rate revision, it is necessary to consider possible deterioration of the pipes due to electrolysis, since in those localities in which the pipes have suffered from electrolysis the actual physical value of the system will be materially reduced.

Inconvenience and Hazard Due to Electrolysis.

It is not alone the property loss, however, that makes the electrolysis problem one of importance. An important fact is the inconvenience to consumers of water, gas, and telephone service due to the interruption of the service when repairs are made necessary by electrolytic damage. Possible interruption of the service of police and fire-alarm systems is also one of considerable importance to almost every municipality.

Wherever currents are permitted to flow on the underground pipe systems there is the possibility of electric arcs being formed when

pipes are disconnected, or when different pipe systems make momentary contact. Accidents of this kind are rare, but they have sometimes occurred, resulting in the loss of life and a considerable damage to property. Cases have occurred also in which leakage of gas resulting from electrolytic corrosion of the pipe has given rise to explosion with disastrous results. Many gas explosions in basements and manholes have occurred, and although it is difficult to determine what proportion is due to electrolysis, undoubtedly some of them are due to this cause.

A water-pipe line weakened by electrolytic corrosion may even present a fire hazard much greater than would result from interruption of water supply at normal times. In many cities it is quite common practice during bad fires to increase temporarily the water pressure in the district adjacent to the fire. It is very obvious that a badly corroded water main might be capable of withstanding the normal pressure on the system and thus give no warning of the weakened condition of the pipe, but at the critical juncture during a bad fire when the pressure is suddenly increased the pipe may burst, and thus seriously hamper the work of fire fighting. It will readily be appreciated that in any region in which electrolysis damage is known to be in progress to a greater or less extent the mains are far more likely to break at these critical times than at any other period, and thus a real, though indirect, fire and life hazard due to electrolysis must be recognized.

Current Work on Electrolysis Mitigation and Related Problems.

In the field of electrolysis mitigation the work has been greatly curtailed during the year since practically all the men formerly engaged in it have been diverted to military problems. The work done has been largely accomplished by a single member of the staff.

Electrolysis Surveys.—Electrolysis surveys were supervised in St. Paul and Duluth during the summer of 1917. In December and January a similar investigation was made in New Orleans. The recommendations of the Bureau are being carried out in St. Paul and Duluth; but no action has been taken as yet in New Orleans. The Bureau has recommended a three-wire system for this city, which, if installed, will be the most complete and extensive system of its kind in this country.

The electrolysis conditions in a number of cities were investigated by conferences with the different companies concerned. In Los Angeles it was found that the three-wire system is being extended to three or four additional substations, and the engineers of the railway company reported complete satisfaction with this type of power distribution. Rather careful study was made of the cause of corrosion of gas mains, and surveys were made in Aberdeen and Hoquiam, Wash.

The Bureau has been asked to supervise electrolysis surveys in Milwaukee, and in Marion, Ohio, and it is expected that this work will be taken up immediately.

Results of Previous Work.—As a result of the Bureau's investigation of conditions in Springfield, Mass., the Springfield Railway Company is preparing to operate their cars on a three-wire system. It is believed that this installation will be completed during the summer of 1918. In the city of Omaha, after a trial of the three-wire

system in the Lake Street district, the main-station district was also converted for three-wire operation, and is now giving excellent results with regard to electrolysis. The Omaha electrolysis committee has just completed a survey, and the results show excellent conditions prevailing over the entire city. The recommendations of the Bureau have been carried out in practically every detail, and the work of the permanent committee has been very satisfactory. It is believed that, as a result of this work, no further important electrolysis trouble will occur in that city.

Revision of Paper on "Electrolysis and its Mitigation."—Technologic Paper No. 52, entitled "Electrolysis and Its Mitigation," has had a wide distribution. Since the original edition has been exhausted, a revision has been made, and a second edition is ready for printing. In this new edition the three-wire method of power distribution has been discussed at some length, and a new discussion of the subject of pipe drainage has been included.

Field tests on lead pipes have been begun to determine the extent of natural corrosion resulting from various kinds of earth encountered in city streets. Specimens have been buried on the Bureau grounds in the following different soils: Compost consisting of leaves and street sweepings, hydrated lime, cinders, Portland cement, fresh street sweepings, vegetable mold. This investigation was instituted as a result of numerous reports of corrosion of pipes and cables from causes other than electrolysis. It will require at least two or three years to secure definite results from these experiments.

Electrical Resistance of Street Railway Roadbeds.—For the past 3 years field work both on city streets and on the Bureau grounds has been under way to determine the electric resistance of different kinds of street railway roadbeds. Some tests are also being made in Madison, Wis., by the Forest Products Laboratory in collaboration with this Bureau. A technologic paper covering this work has been practically completed.

TELEPHONE-SERVICE STANDARDS.

(Systems of telephony; standards of telephone service. This section has also dealt with standard electric cells and has done much of the work on vacuum tubes.)

Telephone-Service Standards.

The investigation of telephone-service standards is of great importance, not only to public utility commissions, but to the telephone-using public at large. Nearly every branch of telephone engineering is involved. Standards of transmission, traffic conditions and the methods of handling traffic, the equipment used in the various systems, including subscribers' instruments, apparatus used in central office and private branch exchanges, and the wire plant necessary for subscribers' lines and trunks all have a very direct bearing on the quality and the cost of service rendered the public. The staff for handling the work has been increased during the year, and it is hoped that a more substantial increase will be possible in the near future so that the work may be more actively prosecuted.

Standards of Telephone Transmission.

Progress has been made in the measurement of the efficiency of telephone transmission, and in the development of standards upon

which this and much allied work must be based. Some of the work done for the military establishments has contributed indirectly to this development. A large number of comparisons of the efficiency of transmitters has been made. A study has been undertaken of problems which are involved in the highly complicated subject of telephone transmission, and a knowledge of which is essential to the interpretation of the results of transmission measurements. On account of the complexity of modern telephone circuits, this is a laborious undertaking, involving not only the development of suitable methods, and the making of measurements under the manifold conditions met in practice, but also the determination of the constants of representative types of telephone apparatus under service conditions. Such work is of great general value, and has also a direct application in question of telephone service with which public utility commissions have to deal, such for example as the feasibility of physical connection between different telephone systems.

Study of Local Telephone Service.

During the latter part of the year nearly the whole time of the Telephone Section has been devoted to a study of the local telephone situation in Washington, in connection with the rate case pending before the Public Utilities Commission of the District of Columbia. This is an unusually important case, involving the problem of deciding on proper measures to meet the unprecedentedly high operating expenses encountered by the local company under war conditions, and also the question of the introduction of automatic switching equipment to reduce the operating expenses, which the commission wished to have investigated. Throughout the case the engineers of the Bureau have acted as technical advisers to the commission. At the request of the Postmaster General a report of the whole matter was prepared and rendered to him. It contained a digest of the hearings held by the commission, analysis of the local telephone situation as brought out in those hearings, and a discussion of the relative advantages and limitations of the manual, semiautomatic, and the fully automatic systems of telephony, with particular reference to their possible use in meeting the emergency in this case. The report was submitted by the Postmaster General to the House of Representatives' Committee of the District of Columbia, and was published as a supplement to the House of Representatives' Report, second session. Arrangements have been made for the engineers of the Bureau to testify in further public hearings to be held by the commission.

Battleship Fire-Control Telephone Equipment.

An important test of battleship fire-control telephone equipment was made for the Bureau of Steam Engineering of the Navy Department. Equipment submitted by 2 makers was so assembled as to facilitate tests in accordance with suggested Navy Department specifications. One of the sets which was tested represented the equipment installed on the U. S. S. *South Carolina*. Equipment submitted by another maker represented two types of circuits and allied apparatus, one being that designed for installation on the U. S. S. *Florida* and the other that already installed on the U. S. S. *Utah*.

The observations made included tests for volume of transmission for intelligibility and for naturalness of the sound transmitted. Tests were also made for mechanical defects and to determine electrical properties of the transmitters.

The Navy Department having made a formal request that the Bureau of Standards assist in drafting new specifications for battleship fire-control telephone equipment, an inspection trip was made to one of the naval bases, where both types of equipment were thoroughly inspected under service conditions and additional syllabic tests were made. These confirmed our laboratory tests.

The matter of new specifications will be taken up as soon as opportunity offers.

Microphones.

A considerable portion of the last half of 1917 was devoted to experimental work in connection with sound detecting devices. Special microphones were designed and numerous experiments were made. Tests were made using various sources of sound and with and without the use of amplifiers.

Considerable experimental work was also done with various forms of microphones for the detection of subterranean sounds. These included the electrostatic and electromagnetic types as well as the usual microphone. Several types were produced which gave fairly satisfactory results. Some of this work is being carried on as time permits with the hope that an acceptable instrument may be produced.

In connection with the microphone work, studies have been made of the theory of the electrical and mechanical characteristics of various telephone transmitters, of diaphragms and membranes, and of vacuum tubes not only as amplifiers, but also as oscillators and detectors.

Standard Cell Work.

The investigation of the cause of the cracking of Clark cells and the best method of preventing it has been continued. Nearly two years ago 18 cells of this type were set up, blanks being employed in which the platinum terminals of the zinc limbs were subjected to the action of zinc amalgam before being sealed into the cell wall. Until this time none have cracked and they have remained remarkably constant.

3. HEAT AND THERMOMETRY.

[Establishment of the standard scales of temperature throughout the range of measurable temperatures; testing and standardization of thermometers, pyrometers, and other temperature-measuring instruments; determination of specific and latent heats, heats of reaction, melting and freezing points, and other properties of materials in the determination of which precise heat and temperature measurements are the principal requirement; standardization of calorimeters; production and distribution of standard heat and temperature samples; industrial applications of heat and temperature measurements; determination of fundamental engineering data involving thermal constants; determination of the fire-resistive properties of structural materials; investigations relating to airplane and other internal combustion engines and their auxiliaries.]

THERMOMETRY.

(Researches on standard temperature scales and thermometric fixed points; standardization of instruments and methods for measuring temperatures up to about 500° C.)

Clinical Thermometers.

During the year, the new clinical thermometer certificates described in the last annual report have been issued and appear to be

giving satisfaction. The new edition of Circular No. 5 on the Testing of Clinical Thermometers has been widely distributed during the year. Specifications for clinical thermometers were prepared for the use of and were adopted by the Medical Supply Dépôt, United States Army.

Some manufacturers of clinical thermometers had been issuing certificates which were misleading, as on any but the most careful inspection it would appear that such certificates had been issued by the Bureau of Standards. The Bureau informed the manufacturers of its desire to have the practice discontinued. The manufacturers, through their association, agreed to discontinue the use of certificates objectionable to the Bureau. It is believed that the use of misleading certificates will be practically eliminated.

Airplane Thermometers.

In July, 1917, an investigation of airplane thermometers was begun. Tests were made of instruments offered by American manufacturers and of such foreign instruments as were available. Investigations as to the nature of tests required and of methods of carrying out such tests were also made. In cooperation with the Signal Corps, specifications for several types of airplane thermometers were prepared. These were among the first specifications for airplane instruments to be issued by the Signal Corps, and served as a type for others. The Bureau was also of service in finding sources of material required in the manufacture of the thermometers. Several inspectors for the Signal Corps received instruction in testing methods in the thermometric laboratory. The Bureau has tested a certain proportion of all thermometers purchased and has made several minor investigations in connection with these tests.

Copper-Constantan Thermocouples.

The Bureau has a small stock of selected constantan wire from which a number of very homogeneous thermocouples have been constructed. A convenient flexible mounting has been designed and several couples have been calibrated at low and high temperatures. It has not, however, been possible to obtain wire of sufficient homogeneity to permit construction of precision couples without considerable care in selection and matching of wires.

Low-Temperature Scale.

A number of vapor pressure thermometers, consisting of a barometric column connected to a tube containing a condensible gas (oxygen, carbon dioxide) were prepared and used in the calibration of several platinum resistance thermometers. The temperature scale so established will serve as a working scale for testing and as a tentative basis for certain low-temperature researches of a military character.

Antifreezing Solutions.

In collaboration with the chemical division, a circular letter on antifreezing solutions for use in automobile radiators was prepared and issued. The freezing points of various glycerin-water, alcohol-water, and glycerin-alcohol-water solutions were determined in the laboratory. The freezing points of a number of proprietary antifreezing compounds containing principally calcium chloride were determined.

Solidifying Point of Naphthalene.

A standard method for determining the solidifying point of naphthalene was required by the Treasury Department for use in the Customs Service. On December 7, 1917, representatives of the various customs laboratories met at the Bureau for a conference which was also attended by several members of the Bureau's staff. A report of preliminary investigations by the Bureau was presented. A method for determining the solidifying point was agreed upon. The Bureau was requested to prepare the detailed specifications for the method and for the thermometers to be used. This has been done, and the thermometers were purchased and tested at the Bureau. It was also agreed that the Bureau should distribute a number of samples of naphthalene to the various laboratories for comparative tests. The samples have been distributed and results should be available shortly.

PYROMETRY.

(Researches relating to temperature scales, melting points, specific heats, latent heats, thermal conductivities, and other properties of materials at high temperatures; heat treatment of materials; investigation and testing of high-temperature measuring instruments; the application of pyrometric methods to industrial problems.)

Pyrometer Absorption Glasses.

A paper on the proper type of absorption glass for an optical pyrometer appeared in Journal of Washington Academy of Sciences. This paper described the specifications for absorption glasses applicable for precision work in extrapolating the high temperature scale. The specifications were adopted by the American manufacturer of optical pyrometers.

Optical and Radiation Pyrometry.

A general outline of the theoretical principles of optical and radiation pyrometry and methods of determining the fundamental constants of pyrometry were described in a paper published in the Transactions of the London Faraday Society.

Optical Ammeter.

A paper was published in the Journal of Washington Academy of Sciences describing a hot-wire alternating-current or direct-current ammeter in which the hot wire is operated at a visible heat. Measurements are capable of high precision.

Standardization of Thermocouples.

Methods suitable for calibration of base metal and rare metal thermocouples and precautions necessary in the measurement of temperatures by means of thermocouples were described in two papers appearing in Metallurgical and Chemical Engineering. This subject is of timely importance and the methods outlined have been followed by many technical industries engaged in the production and heat treatment of shell, guns, and various metallurgical products.

Wehnelt Tube Discharge.

In connection with the determination of certain physical constants, especially latent heat of vaporization, an investigation of the Wehnelt discharge tube was necessary. Two papers upon this subject appeared in Journal of Washington Academy of Sciences showing

that a film of high resistance forms at the surface of a probe wire placed in the anode glow of a Wehnelt discharge. It was found that a potentiometer or electrometer should be employed for measuring the anode fall, or if a voltmeter is used, correction must be made for the resistance of the film. The laws of shunt and series resistance hold for these polarization films.

Simple Method of Measuring EMF Accurately.

Two new methods applicable to determining temperatures with a thermocouple, measuring potential drop across resistance standards, were developed.

Pyrheliometers.

In Bureau of Standards Scientific Paper No. 323 are described methods of calibration and the behavior of the type of pyrliometer used by the United States Weather Bureau for the measurement of solar radiation. Within the errors of observation, the solar radiation scale defined by this investigation agreed with the standard pyrliometer scale of the Smithsonian Institution.

Standard Samples for Thermometric Fixed Points.

The standard scale of high temperatures is most conveniently reproduced by the use of certain pure metals, the melting or freezing points of which have been carefully determined. A large number of such standard melting point samples of very pure tin, zinc, aluminum, and copper were prepared during the previous year. One hundred and twenty-one of these samples were supplied to various metallurgical industries for use in standardizing the master thermocouples used to check the numerous pyrometers throughout the works. That these standard samples have proved of great service to the industries is attested by the fact that the demand for them from arsenals, navy yards, and other industries engaged on military work greatly exceeds the stock which this division has been able to prepare with the personnel and funds available for this work.

Investigations in Electronics.

A series of investigations have been completed on the determination of resonance and ionization potentials for electrons in vapors of boiling metals. When electrons are accelerated in a metallic vapor, two types of inelastic impact between an electron and an atom occur. The first of these results in an orbital shift of the electrons bound in the atom and the second in the complete removal of an electron or ionization of the atom. The potential differences through which an electron must fall to give sufficient velocity for these two types of collision are known as the resonance and ionization potentials for the particular metal in question. Work of this character, which is of great interest from the standpoint of theoretical physics, has also many important practical applications. Thus the data so far obtained have resulted in the determination of one of the important physical constants of optical pyrometry. The work has a direct bearing on problems in illumination by the electrical excitation of gases, on the possible nature of gaseous explosions, on methods of modifying and detecting electrical oscillations, etc. That the possible practical applications are many is evidenced by the fact that several of our largest industrial laboratories are undertaking work of this

character. Papers describing these researches have been published and others are in press.

Thermoelectric Power of Liquid-Solid Metals.

The determination of the thermoelectric power of liquid-solid metal thermocouples is of considerable interest from the standpoint of electronic theory, and of importance in adding to our knowledge of physical constants. The work with tin has been completed, and the investigation will be extended to other metals.

Airplane Gas-Engine Explosion.

This problem has arisen as a by-product of the work on ionization. In the further improved design of spark plug and sparking device for gas engines it is essential to understand the physical mechanism of an explosion. The first step under way in the problem is the determination of whether or not an explosion can be produced by ionization due to photoelectrons liberated by excitation of a metal with Röntgen rays.

Annealing of Optical Glass.

The manufacture of optical glass must be followed by a thorough heat-treating process in order to remove the mechanical strains in the glass. This new problem has arisen with the necessary and rapid development in the American manufacture of optical glasses required in the production of military instruments. For each type of glass it is necessary to determine the temperature at which the glass becomes sufficiently mobile to allow the internal stress to dissipate in a reasonable time. The annealing temperatures of the optical glasses made by the Bureau have been determined by different methods, and investigation is being conducted to establish the relationship existing between the various physical properties of the glasses and the process of annealing. These properties include viscosity, thermal expansion, electrical conductivity, thermal characteristics and transformation points, birefringence, etc. Briefly stated, the object of the present investigation is (1) to determine the temperature at which the strain existing in a sample of glass of specified dimensions is dissipated in a specified length of time, usually 10 hours; (2) to determine the maximum rate at which the glass can be cooled without danger of introducing permanent strain, and (3) to determine the maximum temperature at which the annealed glass can be removed from the furnace without danger of fracture. The above characteristics depend upon the size and kind of glass, but fortunately these may be in general reduced to standard practice, thus greatly diminishing the number of variables affecting the process of annealing. The work has been developed to such an extent that routine tests are being conducted for various American manufacturers, and a complete report will be published later this year.

Temperature Problems in Coke Ovens.

The investigation of the coke ovens ordered by the President in order to determine the relative merits of these two ovens for coking certain grades of coal for use in the iron industry of Illinois and vicinity was made by representatives of the high-temperature laboratories in connection with the study of the temperature conditions under which these ovens are operated. Measurements were made of

temperatures of the coal during coking, of the heating walls, of the ovens while empty, in the regenerators, in the waste-heat flues, in the hot-vapor mains, etc. A considerable amount of valuable information has been accumulated. The work will be extended and a complete report submitted later.

HEAT MEASUREMENTS.

(Thermal constants and thermal properties of materials at low and ordinary temperatures; heats of reaction; investigation and tests of methods and instruments.)

Standard Heat Samples for Use in Calorimetry.

Large fuel contracts are now quite generally based on heating-value tests made with calorimeters. The Bureau has furnished during the year 153 standard heat samples of sugar and naphthalene, which have served the important purpose of enabling users of calorimeters to conveniently check the accuracy of their fuel tests.

Refrigeration Constants.

This extensive series of investigations, undertaken at the request of American refrigeration engineers, expressed through their national associations, includes the determination of the fundamental constants of refrigeration engineering. The work is being carried out with the cooperation of committees of the American Association of Refrigeration and the American Society of Refrigerating Engineers, the members of which have kept in close touch with the work by visits to the Bureau and by means of the reports presented before the annual meetings of these societies by members of the Bureau's staff. The complete series of investigations contemplated under this topic was outlined in the annual report for 1916. Most of the staff engaged on these investigations have been diverted to another investigation of somewhat similar character but of immediate military importance. The work done during the year is briefly summarized in the following sections.

Thermal Constants of Ammonia.

The specific heat of anhydrous ammonia in its liquid and vapor phases and its latent heat are among the most important constants of refrigeration engineering. The experimental work involved in the determination of these constants was completed during the previous year, and a brief statement of the methods employed and the results found was given in the annual report for 1916-17. During the early months of the present year the results of these investigations were finally worked up and have since been published as follows: Bureau of Standards Scientific Paper No. 301, An Aneroid Calorimeter for Specific and Latent Heats; Bureau of Standards Scientific Paper No. 313, Specific Heat of Liquid Ammonia; Bureau of Standards Scientific Paper No. 314, The Latent Heat of Pressure Variation of Liquid Ammonia; Bureau of Standards Scientific Paper No. 315, Latent Heat of Vaporization of Ammonia. Projected work on the specific heat of superheated ammonia vapor was deferred for the future.

Specific Volumes of Ammonia and Ethyl Chloride in the Liquid and Vapor Phases.

The experimental work incident to the determination of the specific volumes of these refrigerants in the interval -50° to $+50^{\circ}$ C.

has been nearly completed. One method used was an application of the well known mass-volume method. An optical interferometer method has also been applied to the determination of the specific volume of the vapor phase, making use of the relation between refractive index and specific volume. When opportunity affords, the large amount of experimental data that has been obtained will be worked up and put into form for publication.

Special Military Investigations.

Several special military researches have been under way in this division during the latter part of the year and have occupied the greater part of the time of a number of the senior men of the division.

LOW TEMPERATURE.

(Production of low temperature down to those of liquid hydrogen (ultimately liquid helium); preparation and storage of pure gases; development of methods of producing and maintaining low temperatures; liquefaction and separation of gases at low temperature; special tests requiring the facilities of the low-temperature plant.)

Low-Temperature Laboratory.

This laboratory has continued to furnish during the year to the several laboratories of the Bureau, as well as to other Government laboratories, special facilities for tests and investigations requiring low temperatures and gases at high pressures. Liquid air runs were made on 36 occasions, the total aggregating some hundreds of liters. Seven compressed air runs were made for the low-temperature comparators in the thermal expansion laboratory. The air compressor was frequently operated for work on noxious gases, for development work on air inductors, tests of silencers, oxygen valves, high-pressure metal hose, etc. Electrolytic oxygen was furnished continuously in large amounts to the chemical laboratories, and for welding purposes. Air and hydrogen, highly compressed in cylinders, were furnished to the various laboratories of the Bureau and to the Signal Corps for special investigations.

The carbon-dioxide cycle was operated almost continuously to provide cooling for the refrigeration constants work; for the thermometer comparators of the heat division, and for development work, by the Aeronautical Instruments Section, in connection with aviators' oxygen regulators. It was also used for tests by other divisions of the Bureau and for low-temperature tests of aeroplane watches, lens systems, electric batteries, rubber samples, and aviators' masks.

The acetylene generator was kept in operation to supply acetylene gas as needed.

A new air liquefier involving a rather unique automatic float valve for discharging the liquid air without waste of cold air was built and installed. While this addition increased the output of the plant to the full capacity of the compressor, it was built chiefly for the sake of providing duplicate equipment as insurance against accident. The liquefier which had previously been depended upon for the supply of liquid air was overhauled and provided with the automatic outlet.

The separate parts of an improved hydrogen liquefier were tested and assembled. This will be put into operation in the near future.

A liquid air and charcoal purifier for hydrogen was built for use on the liquid hydrogen cycle.

Two rotary vacuum pumps were installed for use in series with mercury condensation pumps to give vacua of the order of 0.00001 millimeter of mercury. This assembly of pumps for high vacuum work, while primarily designed for study of rare gases, has proved very useful for the exhaustion of Dewar flasks, mercury arc lamps, special manometers, barometers, and electrical devices.

Preparations have been made to install early in the coming year a new hydrogen compressor and two 90-foot gas holders, deliveries of which are expected within a few weeks. The latter are of the annular type and arranged for variable water loading.

A second electrolytic oxyhydrogen gas generator was installed, thus balancing the load across the three-wire electric circuit.

A gasoline bath, suitable for cooling large specimens to as low as -50° C. by means of the carbon-dioxide cycle, was constructed and has been used frequently for special military tests.

This laboratory has also cooperated in the calibration of a set of orifice air meters for the War Department; the production of liquid oxygen for standard temperature bath; tests of special pressure gauges, and tests of airplane unit sights for fogging with moisture under conditions occurring in aviation.

The Bureau was enabled, with the facilities afforded by the low-temperature laboratory, to prepare a quantity of pure neon from a mixture of helium and neon submitted by an industrial research laboratory. The mixture, from which half a liter of neon was separated, was the volatile inert residue derived from atmospheric air. The neon was condensed in coconut charcoal surrounded by liquid hydrogen and later removed at liquid air temperatures. Members of the optics division kindly assisted in the spectroscopic control.

There is still needed for the completion of the liquid hydrogen plant a compound rotary vacuum pump of considerable capacity for evaporating the precooled air under reduced pressure. This equipment should be provided as soon as possible.

The next stage in the development of the low-temperature laboratory will include provision for the production of liquid helium, thus extending the facilities of the laboratory to the lowest attainable temperatures. It is hoped that funds may be available to provide this equipment in the near future.

FIRE-RESISTIVE PROPERTIES OF STRUCTURAL MATERIALS.

(Standardization of fire tests; fire tests of structural materials and structures; investigation to develop engineering data relative to the fire-resistive features of building construction; investigation and testing of fire-retarding devices; investigation of building codes and fire codes; cooperative work on fire prevention.)

Fire-Resisting Properties of Structural Materials.

The object of the investigations on the fire-resisting properties of structural materials is to furnish architects, construction engineers, builders, State and city building bureaus, insurance interests, and others with fundamental engineering data relating to the behavior and safety of various types of building material and construction when exposed to different conditions met with in fires.

Fire Tests of Building Columns.

Many millions of dollars are spent annually on the construction of buildings, the integrity of which, in the event of fire, is dependent on the behavior of the steel columns supporting the structures. Very little engineering data are available which would permit of any certain conclusions as to the thickness and kind of fireproof covering required to render these columns safe under various conditions of fire hazard. The requirements of city building codes on these questions are so different that it is evident that either some codes are requiring unnecessarily thick fireproof coverings, with undue increase in construction costs, or else other codes are requiring too thin coverings, with undue increase in danger to the stability of the structure under the existing fire hazards.

The fire tests on building columns are being conducted jointly by The National Board of Fire Underwriters, the Associated Factory Mutual Fire Insurance Companies, and the Bureau of Standards. The present program of tests was formulated after consultation with many engineers and architects interested in fire-resisting building construction.

Types of columns.—The types of columns being tested include rolled steel sections, built-up steel sections, round cast-iron sections, steel pipe filled with concrete, vertically reinforced and hooped concrete columns, and wooden columns. At least one of each of the sections is unprotected, others are partially protected by filling the re-entrant portions with concrete, and others are completely protected by various thicknesses of concrete, clay tile, filled and unfilled gypsum blocks, plaster on metal lath, and common brick, in accordance with the methods commonly employed in practice.

Materials.—The materials used in the construction of the test columns and protective coatings have been obtained from various sections of the country, and have been selected with a view to obtaining those representative of their respective classes.

The column coverings have been applied by experienced men in accordance with plans and specifications drawn to secure average results obtainable under ordinary commercial conditions.

Methods of test.—In the fire tests the column, mounted within a gas-fired furnace and kept under normal working load applied by a hydraulic ram of special construction, is exposed to a predetermined furnace temperature rise until the column fails. A record of the temperature at different points within the furnace and at various points within the test sample is obtained by means of suitable thermocouples. The deformation of the column from time to time is determined by means of pairs of nichrome wires inserted into the column at a known distance apart and extending horizontally outward through the walls of the furnace, the wires being run coaxially through fire-clay protecting tubes.

In the fire and water tests, the column is exposed to a furnace temperature built up at the same rate—i. e., in accordance with the standard time-temperature curve that has been adopted for these tests—until the desired temperature rise in the furnace is attained, when two opposite walls of the furnace are rolled out of position by means of trolleys provided for this purpose and the hose stream applied.

Tests completed.—A total of 75 columns have been tested during the year. These comprise 10 tests of unprotected steel and cast iron columns, 11 tests where the metal was partly protected by filling the reentrant portions or interior with concrete, 24 were protected by 2-inch and 4-inch concrete coverings, 17 by 2-inch and 4-inch hollow clay tile, 2 by common brick, 5 by single and double layer of Portland cement plaster on metal lath, and 6 were vertically and laterally reinforced concrete columns. The coverings and columns were designed according to standard methods of current practice applied in a manner best adapted to secure quality of workmanship obtaining on ordinary construction work. Under the conditions of the tests the columns so far tested stood up for periods varying from 11 to 35 minutes, for the unprotected steel and cast iron columns, to over eight hours for the heavier types of full protection, which demonstrates the danger incident with the use of unprotected columns even under conditions of moderate fire hazard and also the practicability of obtaining adequate protection with the use of moderate amounts of covering materials properly selected and applied. The effectiveness of the protection was found to vary greatly within any given class of protecting materials depending for example upon the aggregate used in the concrete, the type of clay in hollow tile, etc., while duplicate tests with a given material showed only relatively small differences in the protection afforded.

Several hundred tests to determine physical, chemical, and thermal properties of the materials used have been made by this Bureau, as also calibrations of the loading ram of the column furnace and accessory testing machine.

A relatively small number of tests are required to complete the program, after which the results will be prepared for publication.

A brief prospectus of the proposed tests was issued early in the year.

Fire Tests of Reinforced Concrete Columns.

Fire tests of reinforced concrete columns now being carried out at the Pittsburgh laboratory are intended to supplement the column tests being made at Chicago, as the latter relate mainly to structural steel columns. The equipment installed for these tests was briefly described in the last annual report.

Types of columns.—Fifty-four columns have been cast. The columns include square sections 16 by 16 inches with 2 per cent vertical reinforcement, and circular sections 18 inches in diameter, some with 2 per cent vertical reinforcement, others with 2 per cent vertical and 1 per cent of spiral reinforcement, and a few without reinforcement. In all cases the covering outside of the reinforcement was 1½ inches of concrete. All columns were 8 feet 9 inches long. Two types of aggregate, washed river gravel and a high calcium limestone, both from the Pittsburgh district, were used. Preliminary tests of 4 aggregates showed the ones selected gave concrete of very poor and very good fire-resisting properties, respectively.

Methods of test.—Three columns of each type were made. One of these was tested to failure when cold. In the fire tests the column, mounted within a gas-fired furnace and kept under normal working load applied by a hydraulic ram, is exposed to a predetermined furnace temperature rise until the column fails, or until the end of 4

hours. If failure does not occur in the 4-hour period, the load is increased to 600,000 pounds, the limit of the testing equipment; if this does not cause failure, the column is allowed to cool and is subsequently tested to failure in a large testing machine. During the fire test a record of the temperature at various points within the furnace and within the column is obtained by means of suitable thermocouples.

Tests completed.—Forty of the columns have been tested. The most notable result of these tests is the earlier failure of the gravel concrete columns, due principally to the spalling off of the outer perfecting layer of concrete, thus exposing the steel and load bearing concrete to the fire. For example, a square limestone-concrete column, with 2 per cent vertical reinforcement, had lost about 55 per cent of its strength at the end of the fire test, while a similar gravel concrete column had lost about 80 per cent of its strength.

Of the cylindrical columns with 2 per cent vertical reinforcement, the limestone concrete columns showed about the same loss of strength in the fire test as the corresponding square columns, while the gravel concrete columns showed less loss of strength than did the corresponding square columns.

Of the cylindrical columns with 2 per cent vertical and 1 per cent spiral reinforcement, the limestone concrete columns showed the smallest loss of strength and the gravel concrete columns the greatest loss of strength of any of the columns tested.

Supplementary tests.—In order to determine the effectiveness of an additional outer layer of fireproofing material to prevent spalling of the concrete, additional tests were made of gravel concrete columns. One of the square gravel-concrete columns, which was protected with one inch of gypsum plaster with very light expanded metal reinforcement, lost only about 40 per cent of its strength in the fire test. The cylindrical vertically and spirally reinforced gravel concrete columns, with a similar additional protection, withstood the 600,000 pounds load at the end of the fire test, and one column tested subsequently when cold had lost only about 10 per cent of its strength.

It is clearly indicated that aggregates high in quartz introduce a serious hazard in fire-resistive concrete, but that this hazard can be practically eliminated by the use of suitable protective material.

These experiments have a bearing on the use of protective coatings to take care of the fire hazard, together with a possible reduction in the high factors of safety at present considered necessary in concrete construction. The experiments with protective plasters of various types will be continued.

A more detailed progress report describing the fire test on reinforced concrete columns has been published in the Proceedings of the American Concrete Institute.

Strength of Metals at High Temperatures.

An apparatus for determining the compressive strength and elastic properties of materials as affected by heat has been completed during the year. This has a maximum load capacity of 100,000 kilograms and will take specimens up to $12\frac{1}{2}$ centimeters diameter and 25 centimeters long and subject them to temperatures up to 800° C. The load is applied by hydraulic pressure within a horizontal restraining frame of structural steel, the heat being supplied by a circular elec-

tric furnace with concentric end coils to compensate for conduction losses. The deformation is measured over a 15-centimeter gauge length using microscope settings on wires attached to the specimen and extending to the outside of the furnace. A series of 60 tests on specimens of structural steel, cast iron, and concrete is under way which it is expected will give much needed information on the properties of these materials at high temperatures.

Building Codes, Information, Cooperative Work.

Considerable correspondence has been carried on with engineers, State fire marshals, and others interested in fire-protection work, and the bureau has cooperated with committees on the standardization of fire tests and on safety to life.

Cooperative work has been done by participation in committee work and in the preparation of reports for the Office of the Quartermaster General on the following subjects: Handling of petroleum and coal-tar products, spontaneous combustion of cotton in bales, the fire hazards in connection with wet and dry processes of cleaning and sterilizing Army uniforms, plaster wall boards, paper safety matches.

Some work has been done in collecting, for the Tariff Commission, information regarding the hazards of the various kinds of imported safety matches.

Further work has been done on an index for collating information relating to fire-resisting features of building construction.

Comparisons have been made of 15 city building codes in reference to the following features of building construction: Height of buildings; wall thickness; fireproofing of building columns, etc.

The section on "The fire hazard in the home" for the Bureau of Standards Circular 75, on Safety for the Household, was completed and the circular published.

AIRPLANE POWER PLANT.

(Investigations and tests relating to airplane engines, fuels, carburetion, cooling systems, ignition systems, and other auxiliaries, with special reference to conditions of temperature and pressure obtaining in actual use; special problems in lubrication.)

Altitude Laboratory.

There has been constructed an altitude laboratory, in which aeronautic engines can be tested under all conditions of temperature and pressure met with in flight. This apparatus is housed in a temporary building of 24 by 50 feet floor area. This laboratory was completed in January, and investigations have been under way continuously since that time. A total of about 120 sets of observations have been made covering 500 or 600 hours actual engine operation.

Results of utmost importance have been secured on various features of engine performance at different altitudes. Confidential reports of about 12 in number are in the course of preparation covering part of the results obtained in these results.

Additional Equipment.

A second 24 by 50 foot building has been constructed in which is housed a 400-horsepower dynamometer with necessary testing equipment and a torque stand on which engines can be run with propeller load. These two units have been in use since their completion for spark-plug and lubrication tests and other special tests described below.

Spark Plugs.

An investigation of the design and characteristics of spark plugs and ignition appliances was undertaken in 1917 and has been continued throughout the year. Methods of testing spark-plugs have been developed and, on recommendation of this Bureau, adopted by the Bureau of Aircraft Production. A systematic study has been made of the electrical and mechanical characteristics of some 50 different porcelain compositions for the purpose of selecting the best material for spark-plug insulators. This investigation has led to the adoption of a porcelain having a marked superiority to any porcelain previously used for the purpose.

The Bureau has taken charge of the routine testing of spark-plugs for the Signal Corps and the Bureau of Aircraft Production, for which purpose aeronautic engines have been in operation a considerable part of the time on the dynamometer laboratory torque stand.

A study of the characteristics of a number of different types of magnetos has been completed and has yielded results of value. The results of the ignition investigation are included in some 15 confidential reports, some of which have been compiled and distributed.

Carburetion.

A study of the problems of carburetion for aeronautic engines has been under way partly in connection with the tests in the altitude laboratory. Results of utmost importance have been obtained indicating serious faults with all existing carbureting systems at high altitudes and furnishing data from which it is hoped radical improvements may be developed.

Radiators.

A fundamental study of the problem of radiator construction for high-speed airplanes undertaken in 1917 has been continued throughout the year. Careful analyses have been made of the performance of something over 100 radiator designs under various conditions of air speed and air temperature. The results of this investigation are being compiled into a series of confidential reports now nearly completed. The work done so far represents substantially a completion of the program as adopted a year ago. There remain several important features of this problem to be undertaken. Additional information is needed on the performance of radiators in flight; on the characteristics which are desirable for radiators placed in various positions on fuselage; on the effect of radiator design and location on head resistance of the plane; and on the effect of surface and length of radiator cells.

Lubricants.

Investigations of the behavior of a number of typical airplane engine oils have been carried out and engines running on the test stand. Analyses have been made of the used oils from engines which have been running in the altitude chamber from which valuable information has been secured. Recently a more fundamental laboratory investigation of the characteristics of different oils has been undertaken and has already yielded results of considerable interest.

Special Tests.

Special tests have been made on the performance of two new models of the Hispana Suiza engine in the altitude chamber with

special reference to proper carburation; of Liberty engines on the dynamometer stand and torque stand, with special reference to characteristics of performance, durability, and lubrication. In addition to this, tests of several experimental engines have been undertaken, in particular, one engine, designed under the direction of the National Advisory Committee for Aeronautics, was subjected to an extended series of tests. A brief series of investigations was undertaken with an experimental 1-cylinder Liberty engine. This engine has recently been mounted on a special test stand for the purpose of studying temperature and pressure distribution in the cylinder and in the various moving parts with a view to solving some difficult questions as to ignition and lubrication.

Activities in Conferences, Committees, and Scientific Societies.

Members of the Bureau have participated in numerous conferences with representatives of the military and other departments of the Government and with technical men visiting the laboratories. The committee work has frequently involved long and continuous service on committees considering important new military developments.

Ten papers bearing upon pyrometry and related subjects were presented before various scientific societies, such as Washington Philosophical Society, American Physical Society, and Optical Society of America. Abstracts of these papers have appeared in Journal of Washington Academy of Sciences, Physical Review, and Proceedings of National Academy of Sciences.

Heat and Thermometer Tests.

The tests completed in the heat division during the year are summarized briefly, as follows:

The number of mercurial thermometers of various kinds, exclusive of clinical thermometers, submitted for test, was 4,951, of which 4,464 received certificates or reports. Among those submitted were 341 Parr calorimeter thermometers, 19 high-precision calorimetric thermometers, 146 Beckmann thermometers, 56 clinical standards, 2,330 industrial thermometers for the United States Shipping Board, Emergency Fleet Corporation, and the remainder laboratory and special thermometers of various types ranging from below 0° to 500° C. Two hundred and forty-eight indicating airplane thermometers of the vapor pressure and liquid expansion types were tested for the United States Signal Corps, the Navy Department, and various manufacturers. Of the 15,039 clinical thermometers submitted, 13,151 received certificates or reports giving results of test. In addition to the above there were tested 9 platinum resistance thermometers, 4 thermocouples, and freezing point determinations were made on 25 samples of materials (naphthalene, toluene, and fire-extinguisher liquids).

In the high temperature laboratories the following tests were made: One hundred and fifty-four thermocouples; 13 indicating instruments for thermocouples; 23 homogeneity tests of thermocouples; 18 optical pyrometers; 5 absorption glasses; emissivities of 3 metals; heat resisting properties of 22 materials; heat treatment of 54 materials; melting point of 52 refractories; and 19 special tests. One hundred and twenty-one samples of metals with certified melting points were furnished to the technical industries. Among the special tests made in these laboratories the following may be mentioned:

Preparation of 400 standard melting point samples; life test of thermocouples; melting point of pyrometer porcelains; annealing of 5 samples of optical glass, 3 of which were 8-inch cubes for periscope heads; annealing temperature of 15 samples of optical glass; maximum safe temperature for removing various optical glasses from annealing furnace; specific heat of 2 samples of fire brick and 1 sample of gun metal; test of several thermocouples installed at the Washington Navy Yard; melting points of 2 aluminum soldering fluxes; temperature of 3 illuminating bombs for the Signal Corps; cooperation with the American University Station, Bureau of Mines, in the manufacture of arsene and other poisonous gases (50 furnace heats made); temperature measurements in Roberts' and Koppers' coke ovens.

The tests made in the heat measurements laboratories were: Standardization of 1 gas calorimeter; heat of combustion of 1 sample of fuel oil and of a number of samples of airplane engine fuels; the thermal conductivities of 32 samples of insulating materials; the thermal leakage of 7 food containers. One hundred and fifty-three standard combustion samples were furnished for the standardization of calorimeters.

The tests made in the low-temperature laboratory, either by its staff or in cooperation with others using the facilities of this laboratory, have been referred to under the section of this report relating to the low-temperature laboratory.

The total work of testing accomplished during the year greatly exceeds that of any previous year, and its increase is very considerably greater than the increase in the personnel engaged in this work. At least 75 per cent of the total testing was done directly for the various military and civil bureaus of the Government, and most of the remainder for industrial establishments engaged on Government work.

Information Furnished.

Several hundred letters and reports relating to the work of the heat division were prepared in reply to requests for information on testing of temperature measuring instruments, methods of temperature measurements, calorimetry, thermal conductivity, thermal constants, etc. Many engineers and technical men have visited the laboratories for consultation on special problems. A considerable number of devices were submitted for examination and criticism.

4. LIGHT, OPTICAL INSTRUMENTS, AND SOUND.

[Development of photographic plates sensitive to red and infra-red light; use of these color-sensitive plates in spectral investigation and for landscape photography; standards and testing of sugar and other materials by optical means; investigation of magnetite and optical properties of magnetic substances; color measurements and specification of color standards; artificial daylight; spectral transmission of dyes and other materials; interferometry; design of optical instruments; testing of optical systems; production and testing of optical glass; radiometry; transmissive and reflective properties of various substances; dispersoids; investigations in sound.]

SPECTROSCOPY.

(Measurement of standard wave lengths of light; application of such standards to the measurement of wave lengths of the spectra in chemical elements; development of data for the spectroscopic analysis of chemical compounds, alloys, minerals, etc.; development of photographic methods for investigating the red and infra-red spectral regions.)

Red and Infra-Red Spectra of Chemical Elements.

Researches in the red and infra-red spectra of chemical elements were continued during the past year with the aid of specially sensi-

tized photographic plates. Ordinary plates stained with photographic dyes such as pinacyanol and dicyanin were used for this purpose and a large amount of spectroscopic data has resulted.

The arc spectra of iron, cobalt, nickel, chromium, manganese, silicon, gold, silver, zinc, lead, aluminum, tungsten, and molybdenum were photographed in the region of long wave lengths. In order to determine to what extent photographic methods with a large diffraction grating are applicable to the infra-red spectral regions, the spectra of iron, cobalt, and nickel were photographed to the extreme limit which it is practicable to reach with our apparatus and photographic method. A large concave grating was used, and exposures up to 10 hours' duration registered many lines with wave lengths greater than 10,000A, or 1 micron. In the arc spectrum of iron, 298 lines were measured between the wave-length limits 6,750A and 10,689A; 606 lines were measured between 5,503A and 11,823A in the arc spectrum of cobalt; and 290 lines between 5,504A and 10,843A in the arc spectrum of nickel. These results (Scientific Paper No. 324) demonstrated that an invisible long-wave interval as large as the entire visible spectrum is accessible to photography with dicyanin stained plates. The incompleteness of spectroscopic data for these longer light waves invites extensive application of this method of spectrum photography.

A scientific paper entitled "Measurements of Wave Lengths in the Spectrum of Neon" has been completed and presented for publication. This paper contains the wave lengths of 55 strong lines in the red and violet portions of the neon spectrum. Interferometers were used to measure the wave lengths in terms of that of the red radiation from cadmium, which is the fundamental standard. The probable error of these wave lengths is about one part in seven millions, and these values will therefore be of importance as spectroscopic standards. Differences of vibration frequencies corresponding to these wave lengths are found to be exactly constant within the limits set by the accuracy of the wave lengths.

In addition to the strong lines mentioned above, the wave lengths of 189 less intense lines in the red and infra-red spectrum of neon were determined with the aid of a large concave grating and are included in this publication.

Other spectroscopic researches described in the last annual report were published during the past year as Scientific Paper No. 312, "Wave-Length Measurements in Spectra from 5600A to 9600A," and Scientific Paper No. 318, "Application of Dicyanin to the Photography of Stellar Spectra."

Red and Infra-Red Spectrum of the Sun.

A map of the solar spectrum from 6800A to 9600A was made from spectrograms obtained at the Johns Hopkins University last year, and this map was reproduced in the January number of the *Astrophysical Journal*. Measurements of the original photographs reveal nearly 2,000 Fraunhofer lines in this part of the solar spectrum. Thus far about 400 of these solar wave lengths have been identified with those of emission lines in the red and infra-red spectra of 19 of the chemical elements which have been studied in our laboratories.

Through the courtesy of Director Frank Schlesinger, the Porter spectrograph at Allegheny Observatory was used during the past

year for the continuation of work on the solar spectrum and data were collected to permit the absorption lines in the solar spectrum to be classified as solar or terrestrial. This spectrograph was designed for work on the rotation of the sun and served to separate the solar from the telluric lines by means of the displacement suffered by solar lines in consequence of the solar rotation. Excellent spectrograms were obtained between 5600A and 9400A, but instrumental difficulties made it impossible to photograph the spectrum beyond 9400A in sharp focus. Between these limits over 3,000 absorption lines were recorded, of which number about two-thirds were shown to be due to absorption of oxygen and water vapor in the earth's atmosphere. More extensive application of stained-plate photography to astronomical subjects promises to yield further important results in astrophysics.

Refractive Index and Dispersion of Air.

In connection with spectroscopic work it is necessary to know some of the optical properties of air. For example, the difference in the index of refraction of the air for different wave lengths must be taken into account in the measurement of standards of wave lengths, and for the proper discussion of numerical relations among spectral lines it is necessary to reduce wave lengths which have been measured in air to their value in a vacuum. This requires a knowledge of the index of refraction of air of various densities for a large range of wave lengths. Over 1,200 observations on the index of refraction of air of various densities were made for wave lengths from 2200A to 9000A, which is the entire spectrum range easily recorded by direct photography. Tables were prepared to enable the proper corrections to be made to standard wave lengths measured in air whose density is not normal and also make possible the conversion of wave lengths or frequencies measured in air to their values in a vacuum. The computations were completed during the past year and the results prepared for publication in Scientific Paper No. 327.

Landscape Photography With Red-Sensitive Plates.

The success in spectrum photography with plates sensitized to red and infra-red light with photographic dyes has led to their application to landscape photography. Their greatest importance arises from the fact that ordinary plates are sensitive only to shorter waves in the blue portion of the spectrum and these waves are largely scattered in the atmosphere. The intensity of this scattered light in the sky varies inversely as the fourth power of the wave length, so that red light of twice the wave length of blue would be scattered only one-sixteenth as much. The great value of red-sensitive photographic plates in penetrating the haze due to light scattered in the atmosphere has been fully demonstrated. Another important characteristic of these red-sensitive plates is their power to detect camouflage designed to defeat the eye. It has also been shown that in certain cases where contrast is especially important it is brought out much better by making use of red-sensitive plates.

Comparisons of numerous types of American and European commercial color-sensitive plates have been made. These plates have been compared among themselves and with plates sensitized by staining with dyes in our laboratories. This investigation has shown

that when certain dyes are applied to the proper photographic emulsions, the plates are superior to any others which have been available for this comparison, and these include the most recent commercial orthochromatic and panchromatic plates.

Appreciation of the importance of photographic dyes has created an interest in their production in this country. Heretofore the best photographic sensitizers were manufactured only in foreign countries, but now a number of chemists in this country are engaged in the problem and have already succeeded in making some of the most important dyes. The sensitizing power of a number of domestic dyes has been tested at this Bureau, and the outlook for American photographic dyes is very hopeful.

In connection with these color-sensitive photographic plates the question of color filters has received considerable attention. Screens showing the greatest possible transmission of light in certain spectral regions are required and the production of such filters for use in special photographic work is of great importance. In the same connection some work has been done in designing photographic lenses which are corrected for the longer waves.

Spectroscopic Analysis.

Considerable time has been given to analyses by the spectroscopic method. The spectroscopic method is extremely sensitive and often detects impurities which escape the chemical method. In some cases the quantity of a sample is too small for a successful analysis by chemical means. The presence of all the constituents of a compound in a single small sample can generally be tested quite easily by a spectrum examination, while the chemical method often requires several portions of the material, each one of which is separately examined for a certain element or group of elements. Coordination of the results of spectroscopic and chemical analyses of standard samples in certain cases makes possible the substitution of a rapid and accurate spectroscopic method of quantitative analysis for a cumbersome chemical method. In cases where the chemical quantitative analysis can not be replaced by the spectroscopic method a rapid preliminary qualitative analysis by the spectrum often saves the chemist much time.

During the past year spectroscopic tests were made on a large variety of materials of which the following may be cited as typical.

The constituents of samples of optical glass and of colored glasses were found spectroscopically, and some of the materials used in the manufacture of optical glass were examined for impurities which might color the glass.

At the request of the zinc-refining industry, a considerable number of ores, electrolytes, anodes, etc., were examined to detect impurities which gave trouble in electrochemical processes.

A variety of cored and impregnated carbons used in electric arc searchlights were analyzed.

The spectra of various poisonous gases were examined, but it was found that their instability under the conditions required to produce a spectrum makes it difficult to detect them spectroscopically.

Various alloys such as "hardened" copper, "tempered" aluminum, nickel-tungsten and alloy steels were analyzed qualitatively from their spectra.

Several hundred samples of tin from steam boiler safety plugs were analyzed quantitatively for copper, lead, zinc, and iron by means of spark spectra. This is a case in which routine and wearisome chemical analysis can be replaced by easy and accurate spectroscopic work. Cooperation of spectroscopists and analytical chemists will make spectrum analysis more powerful and practicable in quantitative work.

POLARIMETRY.

(Standardization of materials, including sugars, sirups, and other compounds, by polarimetric methods; precision polarimetry, including the determination of polarimetric constants; development of standard definitions, methods, and instruments; calibration of polarimetric apparatus; standardization of the technology of sugars and related materials; research in all factors affecting the efficient organization of sugar manufacture and testing; sugar standards for precision calibration purposes; laws and principles of magneto optics and their practical application.)

Circular on Polarimetry.

Since the completion of Circular 44, on Polarimetry, referred to in the last annual report, it has been necessary to print two editions, and the third is now under way. The last edition of 1,500 copies was exhausted in three weeks, nearly the entire edition being purchased by the public. The demand has proved to be a confirmation of the Bureau's recognition of the possibilities of polarimetry in both science and industry.

Testing of Quartz Control Plates.

Quartz control plates are indispensable for the accurate daily checking of saccharimeters. Eight of these plates were tested and certified. Two of them, which were improperly mounted in wax, were removed from their original mounts and placed in loose metal holders in such a way as to comply with the Bureau's specifications.

Owing to the fact that all quartz control plates are imported from Europe it has been impossible to secure any for some time. With the object of being of the greatest possible assistance to the sugar industry in this emergency, the Bureau has abandoned its previous practice and whenever feasible is remounting and testing discarded plates in a manner to make them serviceable.

Natural Rotation of Quartz at High Temperatures.

The investigation of the natural and magnetic rotation of light by crystalline quartz at high temperatures has been continued. Additional knowledge of the properties of quartz is of special importance from the theoretical standpoint because of its extensive use in polariscopes and other optical instruments and because of its relation to the problems involved in the study of the history and formation of the earth.

Crystalline quartz has a transition point at about 574° C. At this temperature the crystal changes over into another crystal form with an absorption of heat when passing through the inversion point from a lower to a higher temperature, and an evolution of heat when going down through the point.

At this so-called "inversion point" it has been found that there is an abrupt jump in the natural rotation, its magnitude depending upon the wave length or color of the light used. Also, there is an abrupt change in the direction of the rotation curve below the point, a small temperature change causing a very large change in the rotation, while above even a large change in temperature has very little

effect on the rotation. The curve showing the rotation plotted against temperature was found to be a straight line almost parallel to the temperature axis from the inversion point at $573^{\circ}3$ C. to $1,500^{\circ}$ C.

The Bureau's polarimetric measurements are the first precision measurements ever made at high temperatures, and a new line of attack for many unsolved problems is therefore opened. It is a matter of great theoretical importance that a mere regrouping of the atoms in a crystal can result in such profound changes in its physical properties.

Magnetic Rotation of Quartz at High Temperatures.

When a plate of crystalline quartz is placed between the poles of a magnet it rotates the light passing through it, the rotation due to the magnetic field being superimposed on the natural rotation. The magnetic rotation at high temperature has been successfully investigated by placing the furnace containing the quartz plate between the poles of a large magnet. In contrast to the remarkable changes in the natural rotation of the quartz as the temperature rises, the magnetic rotation is found to be practically independent of the temperature, increasing very slightly as the temperature rises and showing not the slightest effect due to the regrouping of the atoms which occurs at 573° C. The establishing of this fact is of much importance in modern electrical theory.

Standard Samples.

During the past year 64 standard samples of sucrose and 11 samples of dextrose were distributed. These materials are used principally for industrial and scientific purposes, such as the standardization of saccharimeters, for the determination of the heat value of coal and as standards in sugar analysis.

Pure Sugars for Miscellaneous Purposes.

Sucrose has been issued by the Bureau as a standard sample for several years. Being pure carbon, it is widely used as a calorimetric standard in the analysis of coal on account of its high purity and its accurately known fuel value. It is also used as a saccharimetric standard, as a source of pure invert sugar for standardizing sugar analysis, and for other miscellaneous purposes. Similarly dextrose (or glucose) in highly purified form has been issued as a "reducing" sugar standard for use in sugar analysis.

In response to a request from the Army Medical Supply Depot, we have supplied a quantity of our purified dextrose for use in differentiating bacteria of the colon group. This material is not at present obtainable to a satisfactory degree of purity on the general market and we are preparing either to supply it in the necessary quantities or to assist outside manufacturers to prepare it.

One manufacturer has submitted a sample of his purest dextrose for test. While his product still contains considerable impurities, it is hoped that slight improvement in his process will yield a product of sufficient purity for this and other purposes.

It is very desirable that other members of the sugar group be added to the list. They are useful in chemical work and in the differentiation of bacteria. Considerable progress has been made in the production of levulose, a sugar occurring in honey and fruits;

but none of the others have been prepared in pure form by the Bureau.

Influence of Temperature on Speed of Inversion of Sugar.

This investigation begun in the previous fiscal year has shown the exact time required for complete inversion of sugar at each temperature. By "inversion" is meant the transformation of sugar by means of acid into a mixture of dextrose and levulose which has a definite rotation in the polariscope in a direction opposite to that of sucrose. These measurements have shown that the time used in practice is very greatly in excess of that required. During this excessive time the inverted sugar suffers a serious decomposition in the presence of the acid. This precludes the possibility of accurate analysis. As a result of these experiments a new procedure is being developed and an accurate measurement is being made of the rotation of inverted sugar. In these measurements the decomposition of invert sugar is avoided as far as possible.

A determination of the rotation of invert sugar is being made not only at 20° C., the standard temperature, but also at the higher temperatures 28–31° C., which prevail in climates where cane sugar is produced. The importance of this investigation arises from the fact that upon it are based the data for devising the method of analysis of the sugar mixtures which occur in sugar manufacture.

Solubility of Dextrose.

The Bureau has assisted manufacturers in the preparation of pure dextrose by suggestion and by examination of their product. In view of the importance of encouraging the production of the pure sugar, solubility in water has been investigated, since a water solution is always the starting point from which the substance is purified. From these experiments it appears that the solubility increases rapidly with increasing temperature up to about 35°, at which point there is an abrupt change in the crystalline form and a resulting change in the relation of solubility to temperature. These measurements will be carried out at still higher temperatures and complete data on the solubility obtained.

Magneto-Optical Properties of Magnetic Substances.

Research has been continued on the magnetic rotation of metallic films, namely, iron, iron oxides (hematite, magnetite, etc.), and nickel, from room temperature to temperatures as high as 1,000° C. in some cases. This work is the first study of magneto-optical phenomena ever made at high temperatures. The behavior in this region of the substances mentioned is of great theoretical importance, existing theories having been based on the experimental facts observed at ordinary temperatures. The experimental difficulties which had to be overcome were described in the last annual report.

The results obtained now show that the magneto-optical effect (rotation of the plane of polarization of polarized light) for all the magnetic compounds so far studied, becomes zero at temperatures at which their ordinary magnetic properties are lost. This effect is especially clear in the case of nickel, the rotation falling abruptly to zero at about 360° C., the temperature at which nickel loses its magnetism.

In the case of iron the phenomena are much more complex. As soon as the temperature rises above room temperature, the magnetic rotation begins to decrease rapidly. It rises again somewhat at about 800°C ., indicating that some change or transformation in the material is taking place, then falls off again gradually to practically zero at about 780°C ., the α transformation of iron.

In the case of hematite, the phenomena are even more complex and at present unexplainable. The rotation for some wave lengths is negative and for others positive. In some cases the rotation is negative at room temperature, becomes zero at about 400°C ., and diminishes to practically zero again at 700°C . It remains zero up to 800°C ., which was as high as these observations were carried.

Another peculiarity discovered in hematite is that it acquires a "set" in the magnetic field—i. e., after the field is removed the hematite film still shows a rotation, whereas it did not before putting it in the field. The direction of this "set" is changed with the change of direction of the field. It would appear at first sight as if an optically inactive substance were transformed into a naturally active one by placing it for a moment in a magnetic field. This phenomenon is undoubtedly connected up with the residual magnetism of the film as the "set" disappears at about the same temperature (about 400°C .) that the hysteresis of hematite disappears. The field required to reverse the set is about 5,000 Gauss.

Solubility of Sugar and the Causes of Molasses Formation.

Nearly 15 per cent of sugar obtained from beets and cane is lost to the production of granulated sugar in the form of "exhausted" molasses. Exhausted molasses is a solution of sugar, and the non-sugars occurring in the juices from which no further sugar can be obtained by crystallization. It is therefore of practical as well as scientific importance to ascertain the causes of molasses formation. This investigation, which was begun in the previous fiscal year, is proceeding along two principal lines.

First, experiments are being conducted upon the molasses themselves. We are endeavoring to ascertain whether all molasses act in a similar fashion in inhibiting the crystallization of sugar and in what respects the molasses from different locations differ. The behaviors of the two great classes, namely beet and cane molasses, are being compared.

Secondly, the effects of single pure constituents of molasses are being studied from the standpoint of pure physical chemistry, for the purpose of ascertaining what occurs within a solution containing pure sugar and a pure salt in a very concentrated solution.

Some of the theories which have been proposed to account for the formation of molasses already appear to require modification. From what has been already accomplished it now seems probable that the most promising line of attack of the problem of the prevention of excessive molasses formation is an exhaustive study of the complicated chemical reactions involved.

Intense Monochromatic Light Sources.

In connection with the work in polarimetry it has been necessary to secure sources of intense monochromatic light for colors which have heretofore not been available. To this end considerable effort

has been expended upon the production of cadmium amalgam lamps and after much experimenting a lamp using a new alloy has been produced, which promises to open up a new field of investigation.

Constants of the Quartz Wedge Saccharimeter.

The quartz wedge saccharimeter is used almost universally in the analysis of sugar. In Scientific Paper No. 268 the Bureau has described its standardization of pure sugar at the 100 per cent point on the scale. In order to place this standardization beyond question it is proposed to corroborate it with many further measurements. For this purpose pure sugar has been prepared from very varied sources of supply and analyses made to prove the purity of the samples. Sugar from Cuba, Java, Peru, beet sugar from Colorado, and maple sugar from Vermont have all been brought to the highest attainable purity. Such measurements as have been made show that the substance is identical regardless of its source.

Besides those on the 100 per cent point on the sugar scale, some measurements have been made on the lower points in order to correct for changes in rotation due to the altered concentration of the solution.

In addition to sucrose, many other sugars are analyzed on the saccharimeter. In Scientific Paper No. 293 the weight of dextrose (i. e., the normal weight) required to give the same reading as 26 grams of sucrose was determined experimentally. Similarly measurements are in progress on the rotation of levulose. It is desirable that all the common sugars be purified and their normal weights be determined to correspond to the true constants of the saccharimeter.

Customs Laboratory at Savannah, Ga.

The installation of a customs laboratory at Savannah, which was started under Bureau supervision last year, has been completed and the laboratory has been in operation for several months. A Bureau type precision saccharimeter was secured by transfer of the instrument from the New York service. The new laboratory has been of the greatest assistance in collecting the revenue on the abnormally heavy southern shipments of sugar from Cuba.

Utilization of Discarded Polariscopes.

In view of the inability of sugar manufacturers and refiners to obtain polariscopes for use in the chemical control of their factories, it has been necessary for them to use old types of instruments. In many cases the basis of calibration of these polariscopes is different from the newer and recognized types. The Bureau has been consulted in regard to the use of these instruments and has been able to render considerable aid in this respect. The Bureau is continuing to repair and adjust discarded polariscopes for sugar manufacturers in an effort to remedy the existing shortage.

Polarimetric Testing.

During the year 644 cover glasses for polariscope tubes were tested for optical homogeneity. The abundant supply of cover glasses now available is due to the Bureau's efforts in assisting American manufacturers to produce a satisfactory product. It was most fortunate that the Bureau's efforts culminated in the first American-made cover glass just before the war started.

Polarimetric Tests of Raw Sugar.

In connection with the Bureau's supervision of the sugar testing in the Customs Service, Treasury Department, 1,533 exchange samples of raw sugar were tested. Approximately 50 per cent were direct polariscope determinations of the quantity of sucrose present and the remainder were tested for the per cent moisture in addition to the sucrose content.

Sampling of Molasses at Key West.

The changes in the method of sampling molasses in tank cars inaugurated by the Bureau a year ago have given improved results. The samples are now taken at Key West in transit to interior points and shipped to New Orleans for testing. This method was recommended to avoid the expense of installing and maintaining a laboratory at Key West.

Supervision of the Customs Laboratories of the Treasury Department.

During the past year the work incidental to the supervision of the customs sugar laboratories has been greatly increased. This may be attributed to two causes:

1. The heavy importations of sugar from the West Indies, due to the necessity for refining before shipping to Europe.
2. The abnormal routing of shipments due to scarcity of ocean tonnage.

The latter cause results in the unavoidable collection of considerable revenue at interior points of destination where poor facilities or, at best, only inadequate facilities are available for sampling and testing. Nevertheless, the work has been done with accuracy and reasonable dispatch. No protests have been carried into the courts by the importers. The work of assisting the Treasury Department in improving the equipment, personnel, and efficiency of its general customs laboratories has been continued.

Definitions and Specifications for Refined Sugars.

The work of preparing definitions and specifications for the commercial sugars has been continued. However, the progress made has not been as great as had been hoped. This is attributable to the fact that the problem is a far more difficult one than had been anticipated. In order to accurately separate and define the various grades, it will be necessary to resort to every assistance which science can produce. All antagonism on the part of the industry has been eliminated and it is hoped to have preliminary results within the year.

Standard Glassware for Customs Service.

The work of interesting American manufacturers in the production of suitable chemical glassware for the Customs Service has been continued. Good results have been secured on some articles, but in the case of others the results have not been satisfactory. It is now believed that in normal times the service will be able to entirely discard European-made chemical ware for this work.

Bureau of Standards Baumé Scale.

The new Bureau of Standards Baumé scale has already resulted in the elimination of much of the confusion and misunderstanding which has been prevalent relative to density determinations in in-

dustrial work. It is based on the specific gravity values of Plate, on a working temperature of 20° C. and on the modulus 145. It is therefore adapted to the most convenient range of laboratory working conditions and the best available scientific data. Its immediate adoption in industrial sugar work and by scientific investigations has been gratifying. The Bureau has received a number of communications commending its action in this matter.

Basis of Saccharimeter Standardization.

In the last annual report attention was directed to the Bureau's work on the 100° sugar point of the saccharimeter, showing that the better grades of sugar tested over one-tenth of a per cent lower than they should. Since under present conditions it seemed hopeless to secure a correction of this error by international agreement, the Bureau has begun the standardization of saccharimeter and quartz control plates for the industry on the corrected basis. A report of the Bureau's work was submitted to the Secretary of the Treasury, who then requested the Bureau to restandardize all the quartz control plates in the Customs Service. This has been done, with the result that the Government's revenues from imported sugar have been increased by \$60,000 a year. It is now planned to issue a circular letter to all owners of saccharimeters and control plates who have had their apparatus tested by the Bureau on the old international basis, apprising them of the error and of the necessity of correcting it.

Testing of Imported Molasses.

The importation of molasses, principally from the West Indies, has continued to increase and the value of the product per gallon has been enhanced from 100 to 300 per cent. The average polariscopic test shows less than 40 per cent sugar is present.

When the molasses schedule in the tariff act of 1913, in force at present, was drawn, the product was nearly worthless and an ad valorem rate of 15 per cent was fixed. Molasses testing over 40 was assessed 2½ cents per gallon.

The recent rapid increase in value has therefore brought about a very anomalous situation, in that the low-grade product testing under 40 must pay a higher rate of duty than the more valuable product testing over 40.

There has resulted considerable difficulty in the customs laboratories in satisfactorily testing the low grades. The methods in force do not give the precision necessary to meet the situation. The bureau has begun preliminary work on this important problem and is co-operating with the customs laboratories to find a satisfactory solution.

COLORIMETRY.

(Measurement of the factors determining color; standardization of units, methods, and instruments used in colorimetry; development of primary and secondary standards of color, and their applications to the special industries; determination of color composition of light sources, relative color transmission, and reflection of constituent colors; the practical definition of color by formula; and the development of instruments for color measurement.)

Colorimetry.

Colorimetry is the measurement of the factors which determine or serve to specify color. Color is strictly and properly defined as a sensation; but the color of a light source may, nevertheless, be logi-

cally defined as the sensation produced by the light from that source, and likewise the color of an object as the sensation produced by the light transmitted or reflected by it. The fundamental physical basis of colorimetry is spectrophotometry, the measurement of relative emission, transmission and reflection for light of different wave lengths. Color may also be empirically specified by reference to arbitrary colored standards. The work comprised in this section deals generally with light sources, the transparency of materials, and the transmission, reflection, and diffusion of light and other radiant energy by materials. In some problems where color itself is not the prime consideration, still the measurements required and instruments and methods used are identical or similar. Such problems are therefore dealt with in this section. This work is closely related to and interlocks with other sections of the Bureau's work, viz, photography, photometry, and radiometry. Its methods find practical application in chemistry, ceramics, pyrometry, and the testing of textiles, paper, paints, dyes, oils, and other materials, and in specifications and regulations concerning railway and other signals and eye-protective glasses.

Color-Standards Investigation.

The color-standards investigation mentioned in last year's report (p. 86) has been continued, although greatly impeded by the necessary diversion of effort to urgent military work.

The demand for color standardization mentioned in previous reports continues to be insistent. While the fundamental principles of the subject are fairly well understood by a few experts who have given particular attention to it, the practice of color specification is in a very unsatisfactory and indeed chaotic state. This condition is due to the following circumstances:

Lack of agreement as to standards, definitions, nomenclature, and methods, even among those experts who are competent to deal with the subject.

The failure of those most vitally interested in the subject from a practical and commercial point of view to comprehend at all the fundamental principles involved, i. e., a lack of clear concepts by those most interested.

The widespread current use, without standardization, of pseudo standards and empiric methods having no definition or even description other than their maker's or originator's name.

The lack of reliable quantitative data on the fundamental physical, physiological and psychological constants and factors involved.

The lack of well made precision instruments suitable to make the measurements requisite for color specifications.

The purpose of color standards investigation is to provide for the correction of these conditions. The work which the Bureau can do and has already begun can be considered as follows:

1. *Experimental work.*—A. Development of instruments and methods for general fundamental work; B. Determination of fundamental data and establishment of working standards; C. Application of spectrophotometric and colorimetric methods to specific technical purposes; D. Routine tests.

2. *Organizing and educational work.*—A. Cooperation and discussion with experts outside the Bureau for the purpose of develop-

ing and establishing uniform nomenclature and standards; B. Compilation and coordination of previous data, preparation of tables, graphs, etc.; C. The giving of information by correspondence, conference, and circulars.

Extension and Improvement of Spectrophotometric Methods.

The fundamental physical requirement for placing color standardization on a secure and reliable basis is the permanent installation at the Bureau of apparatus for convenient, accurate, and rapid spectrophotometric work by intercompared methods of testing of known precision and reliability. Visual spectrophotometric work has been in progress for several years. Its shortcomings were pointed out in the report for 1916 and plans for improvement and extension mentioned. These improvements and extensions have now been largely accomplished in that the apparatus for determination of spectral transmission by photo-electric and also by photographic means has now been installed and is in actual use. Both of these provide for accurate determinations of transmission for blue, violet, and ultra-violet light; and the photo-electric has been used throughout the greater part of the visible spectrum to wave lengths as great as 600 millimicrons. The photo-electric apparatus has also been used to measure reflection and plans are being made to adapt the photographic to the same purpose. An improved illumination apparatus for transmission and reflection has been designed for use with the König-Martens visual spectrophotometer. Its construction in the Bureau instrument shop was nearly completed at the close of the year. The three methods now in use supplement each other admirably and give gratifying check results. It is intended, however, to study much more carefully the comparison of results and the accuracy of each of these methods. This will involve a great deal more detailed work.

Collection of Specimens of Measured Spectral Transmission.

The systematic classified collection of marked and identified specimens of colored glass has been greatly increased and numerous determinations of the spectral transmission made by different methods.

Standardization of Nomenclature and Forms.

Considerable time and attention has been given to the careful selection and definition of numerous technical terms for our own use and to the standardization of forms and symbols for expressing results. This is preliminary to a hoped-for more general agreement on such matters of form and convention. After further consideration and discussion with others it is expected to incorporate such material in a Bureau circular. This matter has already been brought to the attention of the Illumination Engineering Society.

A Precision Method for the Production of Artificial Daylight.

One of the primary requirements for the establishment of color standards is the experimental realization of artificial light of the same spectral energy distribution as average daylight. For commercial purposes this has been more or less satisfactorily accomplished by others heretofore by screening artificial light sources with blue glass. While these glasses find an important and wide use commercially they do not give a perfect reproduction of daylight and are not

suitable for all purposes of precise specification. As mentioned in the report for last year, the Bureau has developed a novel method of reproducing daylight by means of the rotatory dispersion of quartz. A description of this method with explicit specifications for producing the desired results has now been published. This method will be of basic importance in the establishment of color standards, but it is intended solely for precision work with instruments, and is not a commercial competitor with the blue-glass method. Its scientific advantages over the latter are: (1) A much more accurate reproduction of the desired spectral energy distribution; (2) certain and convenient reproducibility and definiteness of specifications; (3) convenient adjustability.

The Specification of the Color of Light from the Ordinary Light Sources and the Photometry of Lights of Different Color.

The development of methods and apparatus for this purpose was mentioned in the last annual report. Since then another paper further explaining and substantiating these methods has been published. By request of the Cooper Hewitt Electric Co., preliminary experiments on adapting this method to the photometry of mercury vapor lamps have been made; but it has been necessary to temporarily discontinue this on account of the urgency of military tests and investigations.

The Color Grading of Cottonseed Oil.

This investigation which has been in progress for several years has been almost entirely dropped for the present to give place to military work. Otherwise it could have been brought to a satisfactory conclusion. This necessity is greatly regretted, and it is hoped to take up this work again at the earliest opportunity.

Determination of the Spectral Transmission of Standard Pure Dyes and Other Materials.

This work is of immediate importance in order to put dye standards on a secure and reliable basis for the purposes of trade and the assessment of customs by the Government. There is now little or no reliable quantitative data available on this subject. Our own work on it is only beginning, and its proper and satisfactory early completion will require considerable increase in space and personnel. The commercial importance of this work would seem to warrant the additional expenditure required. The Bureau is now in possession of a large collection of important prewar German dye samples. Arrangements are being made to secure other pure standard samples and commercial samples of American manufacture. The necessary elaborate and expensive apparatus for making the determinations is already provided and installed at the Bureau, and the extensive series of determinations required will be undertaken during the coming year. It could be greatly expedited by an additional appropriation of about \$5,000.

Cooperation with Societies and Organizations.

It is the Bureau's policy to cooperate and maintain close relations with technical organizations interested in the work in progress at the Bureau. By invitation, the Bureau's expert in charge of colorimetry has contributed a paper describing its work on color standardization to the Transactions of the Illuminating Engineering Society. This

section of the Bureau was represented at the New York Dyestuff Convention, January 22-23, 1918, and has been represented on committees of the Illuminating Engineering Society, the National Research Council, and the Society of Cotton Products Analysts.

Examination of Glasses Intended to Protect the Eyes from Harmful Radiation.

This investigation mentioned as in progress in the last annual report has been completed and a Bureau of Standards technical paper on it is now in course of publication.

Investigations on Color, Visibility, and Related Subjects for the Military and Naval Authorities.

By far the greater part of the time and effort of this section during the year has been given to work of a military nature. This work has continually increased until at the close of the year it required attention to the almost complete exclusion of other matters. Routine military tests are reported in another paragraph. Besides these, several reports on extensive confidential investigations have been made.

Investigations of the following kinds were in course at the close of the year, but no extensive reports had been issued: Color of searchlights; chromatic camouflage; color specifications for signal flares.

Colorimetric and Related Optical Tests.

Formal reports have been made on the color, spectral transmission, reflection, or transparency of 95 separate specimens or samples submitted for test. These include various colored glasses, eye-protective glasses, colored signal glasses, camouflage material, tracing cloth, binoculars, photographic paper, etc.

By far the greater number of such tests during this year have been of a military nature. There has been a notable falling off in the number of civil and commercial tests. This has been due in part to fewer applications and in part to the military necessity of declining to undertake some commercial tests applied for. Of special note among the military tests, because of its somewhat exceptional nature and the urgency with which the results were demanded by the Signal Corps, was a test of the spectral transmission of binoculars. The bureau was informed by the Signal Corps that the acceptance of several thousand urgently needed binoculars would result from the report on this test.

The following table shows the number of submitted specimens tested for various applicants:

Military Tests.

War Department:	
General Engineer Depot.....	16
Office of Chief Signal Officer.....	12
Chief of Ordnance.....	9
Total, War Department.....	37
Navy Department and United States Navy:	
Bureau of Steam Engineering.....	8
Washington Navy Yard.....	6
United States Naval Hospital.....	5
First Naval District.....	3
Bureau of Construction and Repair.....	2
Total, Navy Department.....	24

National Research Council (military work).....	9
Total of military nature.....	70

Civil Tests.

Civil departments of the United States Government.....	22
Railway.....	2
Manufacturer.....	1
Total of civil nature.....	25

Information, Advice, and Assistance on Colorimetric and Related Optical Questions and Problems.

Besides the preparation of definite reports on tests and investigations mentioned above, a great deal of time and effort has been given to complying with requests for information, assistance, and loans of materials or apparatus. This service is rendered partly by the preparation of letters in reply to inquiries and partly by personal conference. During the past year these questions have been largely of a military nature.

Information, Advice, and Assistance Rendered the Army and Navy and Other War Agencies of the Government.

Assistance has been rendered the war agencies of the Government by furnishing desired information, supplying or loaning materials, and affording laboratory facilities for cooperative experimental work. These services may be briefly enumerated in part as follows:

For the office of the Chief Signal Officer, War Department: Information concerning the ultra-violet transmission of several glasses has been furnished to the Balloon Section. Information concerning camouflage material and color screens (ray filters) has been given to the Science and Research Division. Some of the personnel of the same division have been afforded laboratory facilities and various color screens, mirrors, crystals, etc., have been provided for their use elsewhere. For the General Engineer Depot, United States Army: Laboratory facilities have been provided for cooperative work on the spectral distribution of the light from searchlight arcs. For the Quartermaster's Corps, United States Army: Information in regard to chromatic camouflage. For a company of Engineers, United States Army: Officers and men of this company have been given information and advice on color measurements, chromatic camouflage, color screens, etc. For the American University Experiment Station: Advice in regard to color measurements and specifications. For the National Research Council: Information in regard to ultra-violet photography. For the National Advisory Committee for Aeronautics: Information in regard to chromatic camouflage. For the Navy Department: Information in regard to chromatic camouflage, signaling, searchlights, visibility under water, and transmission and diffusion of light by certain glasses has been given. Special anticamouflage screens have been made and provided. Apparatus and instruments requiring weeks of work have been designed and constructed for certain confidential investigations. For the United States Shipping Board: Information and advice on chromatic camouflage and color specifications.

Information and Advice to Applicants Representing Scientific, Commercial, and Industrial Interests.

The following list summarizes in a general although incomplete way the kinds of information given, together with representative names of the applicants who requested it:

1. Concerning colorimetric and photometric apparatus and methods of measurement and their application to specific problems: Bureau of Plant Industry, Department of Agriculture; United States Tariff Commission; Johns Hopkins University; American Writing Paper Co.; Williams, Brown & Earle; New York Butter Packing Co.; Max Levy; Cooper Hewitt Electric Co.; American Lithographic Co.; Forbes Lithographic Co.; Eimer & Amend; E. I. Du Pont De Nemours Co.

2. Concerning colorimetric definitions, standards, charts, etc.: Artificial Daylighting Co.; Supreme Council Thirty-third Degree Masonry, Southern Jurisdiction; Hon. Clifford Ireland, et al.

3. Concerning colored signal glasses: Navy Department; Bureau of Lighthouses; Pennsylvania Railroad.

4. Concerning methods and standards for color-blindness testing: Sante Fe Railway.

5. Concerning eye-protective glasses: United States Patent Office; F. A. Hardy Co.; safety experts and commissions.

6. Concerning the ultra-violet transmission of certain glasses: Pennsylvania Wire Glass Co.; Corning Glass Works; Vernon M. Dorsey.

7. Concerning colored glass for use in illuminating of telescopic micrometer: United States Naval Observatory.

Determination of Thermal Expansion by Interference Methods.

The thermal expansion of small samples from 1 to 20 millimeters long is determined by methods using the interference of light waves. All the necessary apparatus has been completed for making thermal expansion determinations from liquid air temperature to 1,000° C. During the year tests have been made upon glass for searchlight reflectors, standard gauges, fused quartz, optical glass in connection with the optical glass investigation, and aeronautical instrument alloy.

Gauge Calibration by Interference Methods.

Interference methods for determining the planeness, parallelism, and length of standard gauges have been devised and used. Two sets of gauges ranging in length from 0.05 meter to 4 inches have been calibrated in terms of standard light waves. Further investigation in connection with manufacturers of standard gauges is in progress.

Index of Refraction of Gases and Saturated Vapors.

The work started last year on the index of refraction and dispersion of air has been completed. In order to make the necessary corrections for the humidity of the atmosphere, the index of refraction of saturated water vapors was measured for the temperature range -10° to 103° C.

A special fused quartz interferometer and pyrex glass container were built for this work. Using the same apparatus the index of re-

fraction and dispersion of the saturated vapors, ammonia for the temperature range -50° to $+27^{\circ}$ C. and ethyl chloride for the temperature range -50° to $+50^{\circ}$ C. were measured. One of the objects of this work is to find an accurate and rapid method for determining the density of saturated vapors.

OPTICAL INSTRUMENTS.

(Design of optical instruments; testing and research on optical systems, optical instruments, and appliances such as telescopes, binoculars, cameras, gun sights, and the like, and optical parts such as lenses, prisms, mirrors, parallel plates, etc.)

Airplane Camera.

The design of a new airplane camera using film was begun last year. This camera uses a lens 37-inch focus and takes pictures on film 8 inches square. The capacity of this camera is 75 to 100 pictures at one loading. An additional feature in this camera is the simultaneous photography of several auxiliary instruments on a corner of the film, furnishing desirable information in connection with identification and interpretation of the picture.

Projection Lens.

Due to the great demand for instruments for military purposes, all available manufacturing facilities were impressed into war work. Such industries as use projection lenses found themselves unable to obtain any, and were forced to make plans for manufacturing these lenses. One lens was measured and the construction data supplied to a company, enabling them to make their own lenses.

Instruments for Navy.

A small telescope for use with stadimeters was designed for the Navy and is now being turned out in quantity.

The constants of a gunsight telescope, which will eventually become the standard for the Navy, were measured and work begun to adapt the design to available glass. Further work of this kind will be carried on with other telescopes as the needs arise.

Long-Range Photography.

For purposes of photographing at great distances and obtaining a visible picture, lenses of rather long focal length should be used. Three types of lenses were tried for this work, and experiments are being carried on to determine the best type for the purpose.

Testing of Optical Systems and Glass.

Several hundred optical instruments, comprising binoculars, gun telescopes, periscopes, range finders, camera lenses, etc., were tested for the Army, Navy, Emergency Fleet Corporation, and various manufacturers. Practically all of the instruments were made in America, with optical parts of American-made optical glass, and it is gratifying to observe the high standard of perfection which these products have now attained.

Binoculars.—Auxiliary to the acceptance tests of field glasses, more searching tests have been made of the optical constants of many binoculars. For this work it has been necessary to develop testing methods which enable the tests to be made accurately and quickly. Some of the tests may be made by relatively unskilled persons after a short period of training, but one or two of the tests are difficult to

simplify to this extent. The methods devised are being applied to acceptance tests.

Camera lenses.—A number of camera lenses have been given thorough tests, with special reference to their use for specific military purposes. A large number have been measured for equivalent and back focal lengths. The change in focal length with temperature was investigated to temperatures as low as -35° C. and found to be small.

Military Telescopes.—A number of military telescopes of various types have been examined and the constants of the instruments determined for both the Army and the Navy Ordnance Bureaus. In general, information as to light transmission, definition, field of view, and magnification is desired.

Miscellaneous Tests.—Other tests than the ones referred to above have been made of the constants and quality of lenses, lens systems, and instruments. These tests have mostly been for military bureaus.

Optical Glass Constants.—The index of refraction, dispersive constant, and transmission of many samples of optical glass have been measured. These data have been mostly for Bureau of Standards glass, but a number of determinations for other glass have been made.

In addition to these routine tests a number of determinations of indices for special purposes have been made.

A list of the tests referred to above follows:

OPTICAL GLASS AND INSTRUMENT TESTS.

Binoculars.

For Signal Corps.....	315	
For Naval Ordnance Bureau.....	35	
For General Engineering Depot.....	14	
For Shipping Board (acceptance tests).....	729	
Special tests.....	120	
		1, 213

Military Telescopes.

Gun sight telescopes.....	14	
Range finders.....	3	
		17

Lens Systems.

Photographic lenses:		
Complete tests.....	17	
Focal lengths.....	50	
Radii.....	4	
Temperature change of focal length.....	5	
Special tests.....	1	
Other lenses:		
Focal lengths.....	20	
Radii and constants.....	1	
Condenser lenses:		
For striæ.....	152	
		250

Optical Glass.

Indices of refraction and dispersive constants.....	278	
Transmission.....	183	
		461

Miscellaneous.

Lens test plates, pairs for radii of curvature.....	16	
Refractometer	1	
Goggle lens frames.....	60	
		77
		2,018

Circular on Optical Instruments.

In response to numerous requests for general information on optical instruments a new circular on The Properties and Testing of Optical Instruments has been prepared. In this circular the important characteristics of different types of optical instruments are discussed in an elementary way and methods of testing the performance of such instruments are described.

Optical Glass.

Production.—The experiments in optical glass manufacture have progressed very favorably during the past year. The Bureau of Standards is shipping glass in quantities for the manufacture of optical instruments and the glass is of a very good grade.

Quality.—Some large lenses of a high relative aperture, made entirely out of some of the earlier melts of Bureau of Standards glass, performed excellently. The absorption of the glass is small, being regularly less than 1 per cent per centimeter in the case of the prism flint glasses, and, with the exception of the heavy barium crown glass, seldom running over 2 per cent.

Types of Glass.—The Bureau of Standards is producing glass of the following types:

Kind of glass.	n_D .	v .
1. Light crown.....	1.518	60.0
2. Barium crown.....	1.574	57.5
3. Light flint.....	1.580	42.0
4. Prism flint.....	1.55	50.5
5. Medium flint.....	1.621	36.5
6. Dense flint.....	1.655	34.4
7. Dense barium crown.....	1.610	57.0
8. Borosilicate crown.....	1.517	64.0

Glass for Photographic Lenses.

The Bureau has been successful in producing dense barium crown glass of a usable quality. The light absorption of this glass is still greater than is desirable and there are also more bubbles than could be wished, but the color is good and the glass is free from stones. The index of refraction of different melts varies somewhat, but an improvement in this direction is looked for.

Methods for Testing Optical Glass.

Successive improvements in methods of examining optical glass for bubbles, stones, and striæ have been made during the year.

Optical glass is usually molded in flat slabs, polished on the edges, and is then examined between these two polished faces for bubbles (seed), stones, and striæ. The same examination may be made without polishing, by grinding the edges and then placing cover glasses

against the ground faces, using a few drops of oil between the cover glass and the ground surface. Somewhat more conveniently the piece of glass may be placed in a tank containing a mixture of carbon bisulphide and gasoline of the same index of refraction as the glass. In this method of examination monochromatic light may be used to advantage, and this method is now in use at the Bureau of Standards glass factory. This method has been used with success in testing many small unworked pieces which would otherwise have been discarded for lack of such examination.

The Effect of Striæ in Optical Glass.

An investigation of the effect of striæ upon the performance of lenses and prisms has been undertaken and some progress has been made. The investigation has proceeded far enough to show that the presence of light striæ in moderate amounts does little harm to the image formed by an optical system. This has been demonstrated by tests on many binoculars and on a number of lenses and prisms containing striæ, some of them in amounts great enough to badly impair the image.

Corrosion Tests.

Methods of investigating the weathering and hygroscopic properties of optical glass have been developed and a great many tests have been made to compare the permanency or resistance to corrosion of different types of optical glass from various sources. Gratifying success has been attained in producing optical glass whose surfaces will not disintegrate.

Circular on the Testing of Optical Glass.

For the general use of manufacturers and consumers of optical glass a circular entitled "Testing of Optical Glass" was prepared and distributed. An effort was made to define and explain methods of measuring the desirable properties as well as to describe tests for the detection of common defects in optical glass in such a simple form as to be of assistance in the production of better glass for optical use. The revision and extension of this circular is contemplated.

Nonshatterable Glass.

At the request of the National Advisory Committee for Aeronautics, an investigation was made of the so-called nonshatterable glasses intended to protect the eyes from splinters when accidents occur which fracture the glass used in spectacles, aviator goggles, face masks, wind shields, etc. It was found that the relatively increased nonshatterability of laminated glass and its comparatively good transparency and rigidity even after puncture, give it great importance in devices for protecting the eyes and face.

RADIOMETRY.

(Development of standard instruments and methods of measuring thermal radiation, commonly designated ultra-violet, visible, and infra-red rays; determination of the reflective, absorptive, and emissive properties of materials for thermal radiation; development of standards of thermal radiations; determination of radiation constants; and the measurement of thermal radiation in absolute value.)

Radiometry.

In the general subject of radiometry, investigations have been continued in connection with the improvement of instruments for

measuring weak radiations, using selective radiometers. Considerable time was spent on military work involving radiometry. For this reason the investigation of the radiation constants have been in abeyance.

One of the subsidiary problems undertaken was the adaptation of the Callendar sunshine receiver and the sliding mechanism of the recorder to the diaphragm opening of a camera, which is to be used in obtaining a series of exposures at frequent intervals throughout the day. By connecting the diaphragm with the sliding arm of the recording mechanism the to-and-fro motion of the latter regulates the diaphragm opening of the camera and hence the amount of light reaching the photographic plate.

The incandescent lamps, used as standards of radiation in absolute value were intercompared, and a set of two lamps were standardized for a well known research laboratory. These lamps give the radiant flux per square millimeter area, in absolute value, at a distance of 2 meters from the lamp. They were prepared some years ago by direct comparison with a black body on the basis that the coefficient of total radiation is $\sigma=5.70$, which is close to the value $\sigma=5.72 \times 10^{-12}$ watt $\text{cm}^{-2} \text{ deg}^{-4}$, recently determined by this Bureau.

Among the subsidiary investigations was a determination of the spectral reflecting power of a series of magnalium alloys.

Life Tests of Quartz Mercury Vapor Lamps.

The ultra-violet, as distinguished from the infra-red rays, appear to have a marked effect in accelerating chemical action, as for example, in the fading of dyes. There has arisen among manufacturers of paper, dyes, cloth, rubber goods, paints, etc., a need of information concerning sources, and their constancy of emission, of ultra-violet radiations, for use in testing the lasting quality of their products.

It is well known that the intensity of the radiation (especially the ultra-violet component) from quartz mercury vapor lamps, decreases greatly with usage.

In response to the demand for exact data, during the past year methods were devised for determining quantitatively the decrease in intensity of emission with usage, and measurements were made on radiant-power life tests of a number of quartz mercury vapor lamps.

The data obtained indicate a marked decrease in the total radiation, as well as the ultra-violet component, emitted in the course of 1,000 hours' usage of the quartz mercury vapor lamps now obtainable on the market.

Optical Properties of Balloon Fabrics.

In connection with the general investigation (chemical, mechanical, etc.) of this subject, the transmissive and reflective properties of numerous samples of balloon fabrics was determined, using a hemispherical mirror and thermopile, mentioned in previous reports. Measurements were made also of the rise in temperature when the fabrics were exposed to solar radiation, using a modification of the fine thermocouples mentioned in the report of 1916. The investigation is being continued on a small-sized model balloon.

Photo-electric Properties of Various Substances.

This is a continuation of the investigation mentioned in last year's report. The photo-electric sensitivity of several substances is being determined, for equal energy values, in different parts of the spectrum.

Extensive data have been obtained on the spectral photo-electric sensitivity of molybdenite as affected by temperature, intensity of the stimulus, humidity, etc. For certain radiometric investigations, samples of molybdenite, which are photo-electrically sensitive, may be used instead of a selenium cell.

Infra-Red Transmission Spectra of Various Substances.

The spectral transmission of various substances, including special glasses, colored fluorite, etc., was determined, and the data are now in press.

Some of the glasses examined have narrow spectral bands of high transmission, which renders them useful as transmission screens for infra-red photography and for producing bands of fairly homogeneous radiations without employing a spectroscope.

Glasses for Protecting the Eyes from Injurious Radiations.

In last year's report attention was called to the importance of this subject and that radiometric measurements are the logical basis upon which to specify what constitutes ample protection from ultra-violet and infra-red radiations.

During the past year considerable new data were obtained on the ultra-violet and infra-red radiations transmitted by various glasses used for spectacles. The sources of radiation used were typical of those to which one is exposed in occupational pursuits. For example, the quartz mercury vapor lamp and the magnetite arc, used in these tests, were representative of sources of extremely intense ultra-violet radiation, while the gas-filled tungsten lamp and the sun represented high intensities in the visible and infra-red spectrum. These new data were published in a revised and enlarged edition of Technologic Paper No. 93, Glasses for Protecting the Eyes from Injurious Radiations.

Information Furnished on Radiometric Subjects.

In reply to specific requests therefor information was given on various radiometric matters, such as, for example, the reflective properties of metals useful in searchlights, etc.; thermal-radiodynamic signaling devices; photo-electric substances; eye-protective glasses; the constancy and methods of standardization of sources of ultra-violet radiations of high intensity; emissivity of paints to be used for preventing the heating of certain kinds of electrical machinery; construction of iron-clad Thomson galvanometers; standard blackening of radiometer receivers; and various radiometric questions having a military application.

Publications on Radiometry.

During the past year the following papers on radiometry were published: Technologic Paper No. 93 (second edition, revised and enlarged), Glasses for Protecting the Eyes from Injurious Radiations; Scientific Paper No. 319, Instruments and Methods Used in Radiometry, III—The Photo-Electric Cell and Other Selective Radiometers;

Scientific Paper No. 322, Photo-Electric Sensitivity of Bismuthinite and Various Other Substances.

DISPERSOIDS.

(Investigation of the physical properties of dispersoids, such as smokes, water supplies, biological fluids, optical glass, etc.; preparation and specification of standard dispersoids; development and standardization of dispersoid constants, instruments, and methods of measurement; cooperation in the technical application of dispersoid information in other branches of Government, in science, and in the industries.)

Scope of Work on Dispersoids.

There is a large class of substances of technologic importance which possess in common the characteristic of containing in suspension another substance in a dispersed or finely divided state. All such media are called turbid or heterogeneous, and have been named dispersoids. A dispersoid is more complicated than a homogeneous material because it is always composed of two substances, the suspended particles and the medium in which they are dispersed.

Smoke, fog, condensation nuclei, dust, and powders are examples of turbid gases; water supplies, muddy rivers, lakes, and harbors, ocean turbidity, technical colloidal suspensions and emulsions, and biological fluids are important fluid dispersoids; optical glass, crystals for optical instruments, such as calcite, quartz, and fluorite, and opal or milk glass are solids in which turbidity is an important factor.

The measurement and standardization of the physical properties of dispersoids presents extremely difficult and technical problems. In studying dispersoids the optical properties have been most useful.

For several years the Bureau has been developing instruments and methods in order to standardize measurements in this field. For a quantitative measure of the light scattered by a dispersoid a turbidimeter has been designed and constructed; to measure the size of particle the microscope, ultramicroscope, and corona methods have been used, and to count the number of particles in gases condensation methods have been employed. The problems of evaporation, condensation, convection, diffusion, coagulation, settling, filtration, and the production of standard dispersoids have also been attacked.

This work is of wide application. A satisfactory standard of turbidity in water analysis is much needed in determining the efficiency of the filtration of municipal water supplies. Industrial processes such as tanning, dyeing, and the manufacture of paper involve dispersoids, the quantitative measurement of whose properties would make possible control and improvement. Biological fluids such as sera are already a commercial product of great importance for which a standard of turbidity is needed. Smoke and dust are produced in many industries, and many cities regulate the extent to which they may be discharged into the atmosphere. A more precise specification of such gaseous dispersoids would facilitate the administration of such laws.

SOUND.

(Research and testing upon sound sources, sound-analyzing instruments and appliances; investigation of the theory and methods of sound measurement.)

Sound Investigations.

The Section of Sound Investigation was started in the Bureau in August, 1917. An important part of the work of the year, therefore,

was the establishment of the section and the assembling of equipment for the work to be done. While the demands of military work necessarily took precedence at this time, the apparatus acquired is practically all of it such as has permanent value and usefulness for investigations of a general nature in the subject of sound.

A Koenig clock fork, the most refined instrument yet constructed for the exact measurement of vibration frequencies of tuning forks, has been secured and put into good running order in our shops. The most refined instrument for the measurement of sound intensity is Prof. Webster's phonometer. Prof. Webster has had one of these made for us in his own shop at Clark University, embodying all the improvements he has been able to work out for it.

One of the most promising inventions of recent years in its relation to sound, in addition to its great usefulness in wireless telegraphy, is the "audion" or "pliotron." It is especially interesting and useful by reason of the fact that it serves either as a maintainer or as an amplifier of oscillations. One of these tubes has been secured, and, together with the proper auxiliaries in the way of condensers, inductance coils, etc., forms an oscillator which promises, with suitable acoustic fittings, to furnish a more flexible, dependable, and exact source of sound than any hitherto available.

A good beginning has been made on a collection of tuning forks. Among these is a unique and valuable set of 37 forks covering the range from 523 to 4,186 vibrations per second (that is, three octaves) by semitones, made expressly for the Bureau at a nominal price by a Chicago manufacturer.

Besides these apparatus that have been secured from outside makers two forms of apparatus for sound analysis have been developed. The first of these is a set of "Reed phonometers" similar in principal to Webster's phonometer, but very much simplified, and used in considerable numbers, so as to give data for a number of pitches at once instead of only one. This forms a somewhat elaborate installation, so that for an easy and rapid, though less accurate, indication of the quality of a given sound, a form, again much simplified, of the "phonodeik" was devised and is being used with success.

The section therefore is now equipped with the best type of instruments for determining the three distinguishing features of sounds, namely, pitch, intensity, and quality or composition. It also has a good assortment of sources of sound and standards of comparison.

The work of the year, besides the acquiring and development of these apparatus, included cooperation in certain phases of the work done by members of the engineers of the Army on sound-ranging and advice and help in various problems arising in other sections of the Bureau or other departments of the Government involving the application of acoustical principles of apparatus.

A series of tests was made, in cooperation with the National Advisory Committee for Aeronautics, of the effectiveness of several types of mufflers offered for gasoline engines. In these tests, which are still proceeding, both the Reed phonometer and the phonodeik are being used to find the effect of the muffler on the noise of the engine.

5. CHEMISTRY.

[Chemical composition and purity of material, chemical properties and constants, including researches upon methods of analysis, specifications for technical materials, and preparation of pure materials for standardization work for the Government and for industrial and scientific laboratories.]

Chemical Testing.

The number (18,365) of tests made in the chemical laboratories during the year is double that of the preceding year. Distributed by types of materials they were as follows: Ferrous metals (irons and steels), 2,309; nonferrous metals, alloys, and coated metals, 1,638; cements and cement materials, 5,870; coal tars, asphalts, saturated felts, burlaps, and building papers, 1,056; linseed oils, turpentine, driers, varnishes, and shellacs, 1,052; red lead, white lead, putties, graphite paints, and miscellaneous paint materials, 888; lubricating oils and greases, 649; soaps, nondrying oils, and metal polishes, 630; inks and ink materials, typewriter ribbons, sealing waxes, etc., 406; balloon fabrics, 895; rubber, 676; leather, 1,030; miscellaneous, including flax packing, asbestos, textile materials, etc., 1,266.

The above tests were made for very many Government bureaus and establishments and for States, municipalities, foreign and allied commissions, and private parties, as follows: Agriculture, 64; Commerce, 6,956; Interior, 95; Labor, 6; Navy, 564; Post Office, 294; Treasury, 1,666; War, 6,485; Panama Canal, 1,539; General Supply Committee of the District of Columbia, 406; other Federal institutions, commissions, and committees, 178; State, municipal, and other institutions and committees, 25; foreign and allied commissions, 44; private parties, 43.

By far the major part of these tests were made for the military branches of the Government. Much of the increase over the preceding year occurred in the last four months of the fiscal year 1917-18. If this increase is maintained over the year 1918-19, the number of samples to be tested may reach 30,000.

The New Chemistry Building.

The transfer of the chemical staff to the new chemistry building was completed in August of 1917, although the building still lacked certain important parts of its equipment. These have for the greater part since been installed, but the permanent electrical wiring remains to be done, as also the installation of the vacuum cleaning apparatus.

In consequence of the rapidly growing requirements of the military branches of the Government, the capacity of the building is already largely overburdened and the need for additional space elsewhere is imperative. Designed to accommodate a maximum of 120 workers of all classes, the building now housed on July 30, 1918, about 150. This crowding does not make for efficiency.

Chemical Publications.

The following papers emanating from the Chemistry Division were published during the year, or are nearly ready for publication: Scientific Paper No. 316, Gas Interferometer Calibration; Technologic Paper No. 98, Effects of Heat on Celluloid and Similar Materials; Technologic Paper No. 105, Comparative Tests of Porcelain Laboratory Ware; Technologic Paper No. 107, Comparative Tests of

Chemical Glassware; Technologic Paper No. 113, Determination of Permeability of Balloon Fabrics; Technologic Paper No. 118, Critical Study of the Ledebur Method for Determining Carbon in Steel and Iron; "Rapid Determination of Carbon in Steel by the Barium Carbonate Titration Method," *Journal of Industrial & Engineering Chemistry*, volume 10, page 520, 1918; "Investigation of Ladle Test Ingots, II," to appear in the Year Book for 1918 of the American Society for Testing Materials; "Causes and Remedy for Gas Formation in Ammonia Absorption Systems," *Journal of the American Society of Refrigeration Engineers*; "Toluol Recovery and Standards for Gas Quality," *Journal of Industrial & Engineering Chemistry*, volume 10, page 251, 1918; "Notes on the Color Designation of Oil Varnishes," *Journal of Industrial & Engineering Chemistry*, volume 10, page 475, 1918; "Investigation of Balloon Fabrics by the Bureau of Standards," Third Annual Report of the National Advisory Committee for Aeronautics.

PHYSICAL CHEMISTRY.

(Preparation and purification of materials required in investigation of physical constants, for example, refrigeration of materials, calorimetric samples, etc.)

Chemical Work on Refrigeration Problems.

A number of samples of pure ammonia and ethyl chloride were purified for the Heat Division of the Bureau for use in the determination of important physical constants. Methods of purification and testing previously used were perfected and tried out. The apparatus employed was also used in preparing pure gases for other purposes.

A method was devised for eliminating the formation of noncondensing gas in refrigeration systems using ammonia absorption, whereby corrosion is avoided and the saving of considerable ammonia is made possible. This work has been given considerable publicity by the Food Administration in its circulars to operators and owners of refrigeration plants in part of its campaign to conserve ammonia.

Purification of Materials for Special Purposes.

Samples of pure carbon dioxide and oxygen were prepared by fractional distillation (sublimation in the case of carbon dioxide). The boiling points of these two substances are to serve as fixed points in the reproduction of the low temperature scale, which is necessary for contemplated work on methane.

The purification of mercury has been placed upon a routine basis and it is estimated that nearly a thousand pounds of the metal was purified for the use of the Bureau.

A considerable quantity of pure methane was prepared for use in the determination of its physical constants by the Heat Division.

ELECTROCHEMISTRY.

(Electrodeposition, including electrotyping, electroplating, the latter including investigation of zinc, lead, nickel, copper, silver plating, etc.)

Electrotyping and Electroplating Investigations.

Owing to the increased demands for information on electroplating of military supplies, and to delays in the installation of equip-

ment, not much progress was made upon the study of electrotyping, even though the International Association of Electrotypers had engaged a chemist to assist in this work. Upon his resignation from this position in January the electrotypers were advised not to attempt to replace him at that time, owing to the demand for chemists for military work. Arrangements were then made for a Bureau chemist to continue the experiments upon substitutes for Austrian ozokerite, as the product made from American ozokerite was apparently not satisfactory. Since then, however, the company controlling the domestic deposits has improved its product, which is now extensively used. There is therefore no pressing need for investigation of this subject, although cheaper substitutes might be devised through such an investigation.

The study of electroplating has been principally directed toward the formulation of specifications and definition of methods of operation and testing of military supplies. In general, this work forms a part of the general investigation of protection against corrosion, and is closely associated with the other phases of that investigation. Since it has been found that zinc coatings exert far better protection to iron and steel than do copper or nickel plating, or other forms of protective coating, special stress has been laid on the study of zinc plating. Owing to the extensive use of black nickel plating to produce a black finish upon military supplies constructed of brass or steel (previously plated with copper, or preferably zinc) the methods of black nickel plating are also being studied. The application of lead plating, especially on gas shells, is also being studied.

In view of the fact that there were almost no specifications or satisfactory tests to form a basis for the inspection of plating on military supplies, a conference upon this subject was held at the Bureau of Standards on March 27, 1918. Representative platers and manufacturers of plating supplies were present, as well as officials of the War and Navy Departments and of the Bureau of Standards. Definite recommendations were made, the most important of which were:

1. For protection of iron and steel against corrosion, only zinc coatings should be employed.

2. Where a black finish is required, the black nickel finish should be recommended.

A plating adviser was engaged on May 15, 1918. Since then he has made numerous visits to plants manufacturing military supplies, and has conferred with officials of the War and Navy Departments upon improvements in existing methods. In general, the cooperation and assistance of the Bureau of Standards in this work has been appreciated by the military officials, who have referred numerous plating problems to this Bureau. Among the classes of military supplies to which plating is or may be applied are, aircraft fittings for both land and sea planes, material used in the construction and equipment of vessels by the Navy Department and the Shipping Board, hardware and equipment used by the Ordnance, Quartermaster's, and Marine Corps (e. g., buttons, belt fittings, harness fittings, hardware for tents, ammunition boxes, etc.), fuses and other parts of artillery ammunition, magazines, and cartridge clips for rifles and machine guns, surgical instruments, tableware, and in general, almost

any supplies constructed of metal. So far as possible it is important to have the specifications and methods of testing such products uniform or at least consistent, since often a great variety of work is made or plated in the same plant.

The present equipment at the Bureau for semicommercial electroplating has proven useful not only for research work, but also for occasional plating of articles made in the Bureau shop. If, however, much of such work should be required, a separate small job plating plant should be installed, which might be operated under the supervision of this section. In either case it is desirable to install equipment for the grinding, polishing, and buffing incidental to plating. Since at present there is no suitable equipment at the Bureau for this work, such machinery should be selected with a view to meeting not only the research requirements, but also the probable needs of the Bureau in this line.

METALLURGICAL CHEMISTRY.

(Preparation of metals and alloys required in connection with metallurgical investigations and special methods of analysis for such products.)

Rapid Determination of Carbon in Steel.

The electrolytic method reported upon last year has been still further improved and simplified so that an accurate determination of carbon can be made in $4\frac{1}{2}$ minutes.

Means have been devised for increasing by 50 per cent, with only slight decrease in accuracy, the output of work when using the barium carbonate titration method for carbon in steel.

Determination of Gases in Steel.

Several experimental forms of apparatus were constructed and tried out for determining the nitrogen content of steel by the method of absorption by metallic calcium that was referred to in last year's report. One especially of these promises to give excellent service.

Further progress was made in the development of Goeren's method for determining gases in steel. Several practical applications of this method are indicated by recent metallurgical problems that have been brought to the Bureau by military branches of the Government and by commercial firms.

Further work on the Goutal method of determining gases in steel has confirmed the conclusions reported last year, but before publishing results some additional work will be done.

Supplementary work was done upon the Ledebur method for determining oxygen in steel and a paper on the subject is about ready for publication.

The work referred to a year ago on the oxygen content of steels deoxidized in various ways was continued. The various methods of deoxidation used, namely, by ferromanganese, ferrosilicon, aluminum and titanium, have yielded steels with nearly identical oxygen contents as determined by the Ledebur method.

The work on the Ledebur method made necessary an investigation of certain questions connected with the equilibrium between iron oxide, carbon, and hydrogen. It was found that carbon alone (as iron carbide in this case) reduces ferrous oxide at 800° to 900° C., with formation of carbon monoxide and dioxide; as soon as hydrogen

is introduced there is a partition of the reducing action between the hydrogen and the carbide and the proportions of the reduction products (carbon monoxide, carbon dioxide, and water vapor) formed vary with the rate of passage of the hydrogen. With very low rates not more than 20 per cent of the iron oxide is reduced by that gas; a rate of not less than four liters an hour is necessary to effect a 90 per cent reduction by hydrogen alone. This investigation showed also that the rate of hydrogen passage in the Ledebur method should not be less than 4 liters per hour.

Carbon monoxide is an important constituent of the gases extracted from steel when this alloy is melted in vacuo. Certain hydrocarbons, produced by secondary reactions, are also present in the gases. Consequently, in order to determine carbon monoxide in such mixtures, it is desirable to find a combustion method which will burn the carbon monoxide without affecting the hydrocarbons. By the use of copper oxide at 250° C. as an oxidizing agent it was shown that fractional combustion of carbon monoxide is successfully effected provided unsaturated hydrocarbons are absent. It is believed that suitable absorbents for these have been found. A special form of electric furnace for heating several copper-oxide reaction tubes in series was designed and used for this work.

GAS CHEMISTRY.

(Methods of preparation, purification, analysis, and testing of gases, including fuel and illuminating gas, and special gases such as hydrogen, oxygen, nitrogen, argon, etc.)

Balloon Fabrics.

The work on balloon fabrics has made very satisfactory progress during the past year. After a complete survey of the field a program of work was outlined. This was carried out under the auspices of the Balloon Fabric Committee; the result has been a uniform development of the field. The results accomplished during the past year may be briefly summarized as follows:

The methods of examination and testing of fabrics have been investigated and standardized. A method for the determination of the permeability of balloon fabrics to hydrogen by use of the gas interferometer has been developed and adopted as our standard method. Other methods have been tested and found inferior. Two new methods are now being developed and will be used in conjunction with our standard method as the circumstances dictate. One method depends on the measurement of hydrogen by virtue of its high thermal conductivity. The other method determines the hydrogen volumetrically by an ingenious system.

In connection with this line of work a study of the permeability of rubber to different gases is being made. There is very little information available on this subject, and we have frequent calls for such information in connection with the employment of rubber for holding different gases.

The determination of the durability of fabrics has been studied in detail, with the result that it has probably become one of the most important parts of the Bureau's work. An investigation of the fabrics being used in Navy dirigibles enabled us to show the Navy that the fabrics in at least 9 of their 16 dirigibles then under construction were very poor from the standpoint of their lasting qualities. Only 2 or 3 of these dirigibles were accepted before our results

were reported and service tests confirmed our laboratory tests. We not only effected a considerable saving to the Navy in time and money but stimulated the research activities of the companies responsible for the fabrics to such an extent that a wonderful improvement in quality was obtained in a few months.

In the search for a rapid, reproducible exposure test, a thorough study has been made of the use of ultra-violet light, heating in ovens, exposure to light from tungsten lamps, etc., but no satisfactory substitute for exposure to the weather has been found.

During the winter an extensive series of exposure tests was conducted at Pensacola, Fla., with the cooperation of the Navy Department. The Goodyear Tire & Rubber Co. rendered valuable assistance in these tests by preparing without cost to the Bureau a great number of experimental fabrics at a cost of several thousand dollars. The United States Rubber Co. also prepared a series of fabrics for these tests. The results obtained were very useful to the Army and Navy.

The effect of exposure under tension is now being studied in order to throw light, if possible, on the deterioration of fabrics in dirigibles.

The effect of radiation on balloon fabrics is important from two standpoints: First, the rapid changes in balloon temperature produced by sunshine, and, second, its effect on the lasting qualities of the fabric. A study of these points is rapidly nearing completion. The effect of various coatings and pigments in protecting the rubber is a part of this problem.

The effect of impurities in the hydrogen upon the fabric and the balloon fittings has been reported in a preliminary memorandum. Further work on the subject is still in progress.

A new method of study which is being developed may be mentioned; this is the microscopic examination of thin sections of fabric. It is hoped that the cause of failure of certain fabrics may be determined visually in this manner.

During the year over 1,500 permeability determinations were made. Exposure tests were completed on over 175 fabrics. Sixty new fabrics are now undergoing exposure at Washington.

Much work was done on balloon fabrics, both in analyzing them and in studying the changes undergone in storage and when exposed to weather conditions at Washington and Pensacola.

Balloon-Gas Investigations,

The question of the best methods of preparing hydrogen from ferrosilicon and sodium hydroxide in solution was referred to this laboratory by the National Research Council and made the subject of an extended laboratory investigation, as a result of which we were able to explain all the phenomena connected with the reaction and to determine with certainty the effect of each possible variation in methods of generating the gas. Our report of November 5 covering the laboratory work also included recommendations in the form of specific directions for the purchase of material and the operation of the gas generators. These recommendations are the basis of the present practice of both the Army and Navy. The most important single result of our work was to demonstrate the possibility of greatly reducing the amount of sodium hydroxide used in the process with attendant advantages in plant operation as well as economy. The

saving to the Navy alone from these changes was at one time computed to be \$700 per day.

An investigation was made upon the effect of sodium carbonate in the sodium hydroxide used in generating hydrogen and the results were employed in preparing specifications for the purchase of sodium hydroxide for military and naval use.

Experiments were also made to determine the feasibility of recovering sodium hydroxide from the sludge from the hydrogen generator by precipitating out calcium silicate with lime. Other experiments were made to determine whether sodium carbonate and lime could be used economically in place of sodium hydroxide in the ferrosilicon method. Both these modified processes were shown to be impracticable.

A study of the literature relating to balloon gases was made at the request of the Navy Department and an extensive bibliography on one phase of the subject prepared for their use.

Methods have been developed and apparatus constructed for the experimental study of the inflammable limits and the propagation of flames in mixtures of balloon gases and air.

A gas density apparatus for determining the purity of hydrogen for aeronautical purposes has been designed for the use of the Navy. The bureau has had constructed and supplied to the Navy 25 of these apparatus and 10 to the Army.

A short report on the effect of moisture on the lifting power of balloons was also prepared at the request of the Navy Department.

Gas Analysis Investigations.

During the year the work upon combustible gas detectors was completed. One form of detector was adopted by the Navy Department for use in submarines in competition with the instruments submitted by a number of other laboratories. After some months of service, trouble developed with some of the instruments, partly on account of excessive vibration of the submarines, which had not been anticipated, and partly because the recommendations of this laboratory were not followed in practice. The wiring, adjustment, and calibration of the instruments was then taken over by this laboratory, and means for testing and eliminating the effects of vibration were devised. More than 100 instruments, 60 of which were wired and calibrated in this laboratory, are now in use, and we have just been requested to prepare 500 more. These instruments probably do not cost more than \$30 apiece and replace an instrument costing \$500 which had been tentatively accepted by the Navy Department.

A preliminary study has been made of a number of methods for the quantitative determination of the composition of 3-component gas mixtures which do not permit easy chemical separation. This work was requested by the Navy Department; but some of the results may have wide application in other fields.

A laboratory study of one type of balloon leak detector of foreign manufacture was made at the request of the Signal Corps and recommendations were given for the construction of similar instruments in this country. We have also examined, tested, and reported upon not less than 9 other types of gas analysis apparatus for various purposes.

After several unsuccessful efforts along different lines a satisfactory continuous indicator for the percentage of oxygen in the air has been devised and constructed in a crude form. The completion of a compact assembled apparatus to be used as a model is a task for the immediate future.

Routine analyses of the exhaust gases from the aeroplane engines under test at the Bureau have been made regularly for the past two months. An apparatus for securing instantaneous readings of the combustible gases in the exhaust is under construction.

Several improvements in apparatus and methods for volumetric gas analysis have been made and are in constant use.

A new form of analytical apparatus depending upon the heat conductivity of gases has been devised and tried out in a preliminary way with gratifying results.

The problem of the continuous analysis of the gases in one of the nitrate plants has been considered and a tentative method for complete analytical control of the plant has been worked out. The experimental work on this problem is just beginning. The heat conductivity method mentioned in the preceding paragraph is to be used for much of this work and it is believed that there will be many other important applications for this method.

Miscellaneous Gas Problems.

A great variety of minor problems and questions are constantly coming to the gas laboratory, principally from the War and Navy Departments. The two most important of these miscellaneous problems were the writing of a large part of the Hydrogen Manual for the Navy and the testing of an oxygen supply apparatus for aviators to determine its suitability for supplying more than one person. The latter problem consumed considerable time only because it was necessary to devise entirely new methods for the study.

REAGENTS AND APPARATUS.

(Study of methods of testing reagents and apparatus to be used in chemical analysis, including study of chemical glassware, porcelain, platinum, and platinum substitutes.)

Chemical Reagents.

Work was taken up in cooperation with the American Chemical Society and manufacturers with a view to improving the quality of so-called "analyzed reagents" by a systematic study of the methods of analysis in general use. Owing to the limited force and the present abnormal conditions, not much progress has been made. A representative of the Bureau visited and conferred with a number of manufacturers, and reagents received for the Bureau laboratories have been tested and the makers advised of the discrepancies between the statements on the printed labels and the actual findings. A report has been submitted to the chairman of the committee of the American Chemical Society. This work is of direct interest to all Government departments and to all other users of reagents, and indirectly affects all users of the products of the industries.

Platinum.

The research upon the chemical and physical properties of the platinum metals has been started, the work of the past year consisting mainly of a study of the literature and of the analytical methods.

From the cooperation of the United States Assay Office at New York the Bureau has obtained loans of platinum, iridium, and palladium for this work. It is purposed to undertake the preparation of pure metals and their alloys for a study of their chemical and physical properties. A large part of the work has thus far consisted in the analysis of platinum gauzes for use as catalysts in the oxidation of ammonia by the Nitrate Division of the Ordnance Bureau of the War Department.

Analyses and tests have been made of samples of platinum foil and sponge for the New York Assay Office.

The New York Assay Office, continuing its cooperation of the past year, has made for the Bureau about 60 crucibles, 22 dishes, and several miscellaneous articles with varying iridium content. These have been tested, and, except for minor mechanical defects in some of the dishes, have proved satisfactory.

Asbestos.

A large number of samples of asbestos from various American localities have been tested as to suitability for the preparation of filters for analytical operations. A supply is now on the market equal in quality to that formerly imported.

OILS, RUBBER, PAPER, TEXTILES, INK, AND GLUE.

(Chemical analysis and investigation of oils, rubber, paper, textiles, ink, and glue, with special reference to meet particular requirements.)

Chemical Work on Rubber.

The Bureau has cooperated with representatives of the Army and with manufacturers in drawing up specifications for rubber tires and for certain types of packings for military purposes. A very large amount of analytical work was done on these materials.

The method for the direct determination of rubber that was referred to in last year's report proved very useful in the analytical work on balloon fabrics.

Following a conference at the Bureau, specifications for two types of gasoline hose were prepared. Rubber is preferable to metal tubing for use on airplanes because it does not break when subjected to long-continued vibrations.

Two types of foreign tanks, designed to be tight to gasoline even when punctured by bullets, were tested. A report covering these tests as well as outlining a method for making such tanks, was submitted to the Signal Corps in 1917. Further work in cooperation with representatives of the Signal Corps was done later.

Chemical Work on Leather.

The chemical testing of leather is a new line of work for the Bureau, but one which it was essential to establish in order to get the most out of certain investigations relating to the physical testing. Three chemists are now necessary to carry on the work for the Army and a fourth is engaged in cooperative work with the National Tanners' Association, as well as in studying waterproofing and preservative compounds. Practical tests of shoes made of leather tanned and finished in different ways are in progress at one of the Army camps.

Owing to the cooperation of a Philadelphia tanner, it became possible to obtain specially tanned and finished bends for a com-

parative study of the effect of different methods of treatment upon the durability of leather. This work is still in progress.

Chemical Work on Writing and Other Inks.

During the year an unusually large number of inks of all kinds were tested. Some confidential work was done for the Navy Department, while more and more testing is being done for the War Department. An ink made at this Bureau for self-recording instruments used by the Weather Bureau proved to be as satisfactory as the French ink that was used previously.

Chemical Work on Paste, Glue, and Mucilage.

In addition to the routine testing of paste, some assistance was given to the United States Food Administration in its attempt to conserve wheat flour. To this end several lots of paste made from potatoes, potato flour, corn flour and starch, etc., were prepared and found to be satisfactory for different purposes. Since receiving suggestions from this Bureau the Food Administration has been able to eliminate the use of wheat flour for making paste. Further, by adopting suggestions made by the Metallurgical Division, all the wheat flour that would otherwise have been used in making foundry cores has been saved for food. The Chemical and Electrical Divisions are cooperating in a study of substitutes for wheat flour in making dry batteries. The total saving from all of the above will amount to thousands of barrels of flour in a year.

It is but fair to say that in all its correspondence with paste manufacturers there was observed a willingness to help. From some there were received valuable suggestions or samples which showed what could be done without the use of wheat flour. This occasion is taken to thank those who have given assistance to this Bureau in its efforts to help the Food Administration.

Some work was done on glue with reference to its use in airplane construction, but most of the samples of glue and mucilage tested were not for military use.

Lubricating Oils and Greases.

The Bureau cooperated with the Navy and the Signal Corps in an extensive series of tests of airplane lubricating oils which were made at the Washington Navy Yard.

Much testing of lubricating oils and greases was done for different branches of the Government.

Chemical Work on Textiles and Dyes.

The chemical testing of textiles is a new field of work at the Bureau. A great amount of this was done for the Army. The work included not only the analysis of fabrics, but also tests of the fastness of dyes and on the fireproofing and waterproofing of textiles.

A collection of dyes, chiefly those used for dyeing Army textiles, is being made for an investigation into the best methods for obtaining materials of fast colors.

For the prosecution of certain military work undertaken by the Optical Division of the Bureau a series of pure dyes is being prepared.

Airplane Dopes.

Dope is a name given to certain preparations that are applied to the fabric of airplane wings in order to impart to them certain

essential qualities. The importance of an investigation of these materials was recognized at the Bureau and begun before our entry into the present war. As a result it was possible 7 months ago to draw up very satisfactory specifications, while even 10 months ago the Signal Corps of the Army officially approved 4 dopes which had been tested at the Bureau. As far as possible all phases of the subject were gone into, including not only the testing of dopes under laboratory and weather conditions, but also the production of cellulose acetate and nitrate and their solvents, the use of plastics, fire-proofing materials, etc. The military applications of these matters are obvious.

METALS, CEMENT, AND BITUMINOUS MATERIALS.

(Chemical analysis of metals, including iron, steel, nonferrous metals, alloys such as brass, type metal, solders, etc., coated metals such as tin plate, galvanized metals, etc., lime, plaster, cement, concrete, bituminous materials, including tars, asphalt, roofing papers, roofing felt, etc.)

Chemical Work on Metals and Alloys.

In addition to a large amount of routine testing of ferrous metals and alloys some attention has been paid to improving methods of chemical testing of these materials, and much effort put upon systematizing and expediting work.

Protective Coatings of Zinc.

Much attention has been given to the subject of protecting iron and steel by protective coatings, particularly of zinc.

Investigation of the methods of stripping the zinc coating indicates that the method of treatment with hydrochloric acid and antimony chloride is preferable to that with lead acetate, since the metallic lead precipitated is difficult to remove, especially from irregular surfaces. The antimony chloride method requires longer immersion for sherardized products than was originally specified by its author. It was also found that the thickness of practically all of the coatings is variable, and that microscopic measurements do not give reliable figures for the average thickness.

Certain limitations of the salt-spray test have been discovered which affect the usefulness of this test; for instance, the position of the specimen affects the rate of solution of the zinc coating.

It has also been found that a protecting deposit of a basic salt of zinc is frequently formed on corroded plates which prevents rusting of the exposed base.

The coatings on certain specimens of sherardized materials were found to be so brittle as to be readily removable by sharply bending the specimens. The powder removed by this treatment showed a relatively higher zinc and a lower iron content than the solution obtained by stripping with hydrochloric acid and antimony chloride, which shows that this reagent attacks the underlying iron. The time of action of the reagent is different for materials coated in different ways; an electrically-plated specimen was stripped in from 5 to 15 seconds, dipped specimens are usually stripped in less than 30 seconds, while sherardized coatings require usually more than 60 seconds.

An effort is being made to determine the specific gravity of the zinc coating produced by the various processes so as to permit of

calculating the thickness from the weight obtained by the stripping method.

In order to obtain more definite information regarding the character of the coating produced by the various methods a number of specimens of sheet steel, made from low carbon Bessemer steel, were coated by a number of firms using different processes. These were afterwards exposed to the salt-spray and stripping tests and examined metallographically. Very little relation was found to exist between the thickness of coating as determined by stripping and resistance to the salt-spray test. Hence, an effort has been made to devise a test which can be applied to relatively large samples and which will detect thin spots. The most promising method depends on the use of a solution of sulphuric acid (15 to 20 per cent strength) containing sodium bichromate, which will be further tried out.

Cement, Concrete, etc.

The routine chemical testing of cements, limes, and plasters shows an increase from 1,200 samples for 1916-17 to 5,600 samples for 1917-18.

Special tests and reports of most diverse character were made, some of which are enumerated below.

The Panama Canal Commission was advised regarding the preparation of better specifications for silica sand for steel castings, after a visit had been made to the Washington Navy Yard to observe the practice there followed in the use of that material.

A large number of tests were made in cooperation with Division VII-2 on soils, waters, and concretes, with the object of shedding light on the causes of disintegration of reinforced concrete.

Analyses were made of water, soils, and sands for the Reclamation Service to determine the presence of substances which might be responsible for the slow type of disintegration occurring in constructions of the Crow irrigation projects. The results indicated that the materials used in construction were not the cause of the trouble.

Seven samples of soil from Camp Raritan, N. J., were examined for the presence of any constituents likely to stimulate corrosion of galvanized banding used in the construction of wooden piping.

Analyses of concrete and laitance from a dry dock at Norfolk, Va., showed that the cause of the formation of laitance when concrete is poured was due primarily to the use of an excess of water, with clay in the gravel and the use of waterproofing compounds as contributing factors.

For the Bureau of Mines tests were made of different mixtures of cement, lime, kieselguhr, etc., to be used in gas masks.

For the Department of Concrete Ship Construction analyses and tests were made of samples of sands, slags, diatomaceous earths, prepared clay aggregates, and shales, with the object of producing a light, strong concrete. For the same department tests are being made to determine the value of fluosilicate coatings.

A considerable number of floor hardeners have been analyzed and classified, with the idea in view of carrying out test on the wearing qualities and values of these materials.

At the request of the Constructing Quartermaster General an inspection was made of a car of cement to determine the cause of injury to the eyes and hands of those who handled the sacks of cement in this car. Final results have not yet been obtained.

Bituminous Materials.

The work on bituminous materials has increased very materially during the past year, in spite of the fact that samples from the Supervising Architect have been fewer than in the past. This is due to the military needs resulting from the war.

A number of improvements in methods of test have been made, and this laboratory has collaborated with the American Society for Testing Materials in a series of comparative tests of solubility of asphalts in various petroleum distillates and different grades of ethyl ether. This was necessary as very little work of an accurate nature has been done on this type of materials, and until the last few years virtually no work of standardization of methods has been accomplished. The work on bituminous materials in many of its phases is more or less intangible and many questions remain to be decided. Considering the kind of work and its status of even 5 years ago, it is believed the Bureau is making its influence felt in this field.

In the report for the year ending June 30, 1917, it was noted that the Quartermaster General's Office had requested certain cooperation in passing on prepared roofing purchased for cantonments. A working agreement between the Quartermaster Corps and the manufacturers through the Prepared Roofing and Shingle Manufacturers Association had been arranged, and much of this roofing was furnished under this agreement without test. This arrangement was ineffective and at the present time the Bureau is cooperating closely with the Cantonment Division on prepared roofing. This division still has great need for roofing on new buildings being put up under its supervision, and in the maintenance and repair of roofs laid in the past. The Bureau is consulted almost daily relative to some matters connected with these problems.

It may be mentioned in this connection that representatives of the Bureau and of the Maintenance and Repair Division of the Cantonment Division made an inspection of the roofs at Camp Meade. Requisitions for new roofs to replace the old had been requested from most of the Army camps which aggregated hundreds of thousands of dollars. It was found that the trouble was not due to the quality of the roofing in the case of Camp Meade and that a few hundred dollars for materials and repairs would accomplish the results desired. Investigation is showing the same condition to be true for most of the other camps. The Government has thus been saved many hundred thousands of dollars.

It was suggested in last year's report that this enormous use of prepared roofing on cantonments offered a wonderful opportunity for study of this material in service, and it was further suggested that in a year or so a representative of this Bureau be sent on a tour of inspection to these camps. The time is not yet come, but it is hoped that this opportunity will not be lost when the roofs shall have weathered sufficiently to make it worth while.

The Bureau has been frequently requested to prepare or review specifications for prepared roofing for the Engineer Depot and has tested samples representing hundreds of thousands of squares of material now shipped abroad. Much more of this remains to be purchased and tested.

At the present time the Bureau is working with several branches of the Army and other Government branches on the one hand, and the prepared roofing manufacturers on the other, in the development of uniform specifications for 1, 2, and 3 ply prepared roofings. This work is made more difficult by the present market conditions and the difficulty of obtaining certain raw products, but progress is being made.

In the fall of 1917 the Shipping Board asked the Bureau for specifications for bituminous enamels for the protection of certain inaccessible parts of the inside of steel ships. A provisional specification was hurriedly drawn up from data then on hand, and a more thorough study of these materials was undertaken in order to permit of drawing up better specifications for them. This work had scarcely started when the Philadelphia Navy Yard learned of it, and one of their men visited the Bureau. Arrangements were made for cooperation, and a representative of the Navy Yard was sent to the Bureau to study the problem there for a short time. This work was completed and specifications were sent to the Shipping Board and the Philadelphia Navy Yard.

The Ordnance Department of the Army has asked for aid in the development of bituminous paints for the interior of shrapnel shells. Some paints were made for practical test and specifications suggested.

In cooperation with the American Society for Testing Materials, the chemistry division is studying the penetration needle used for the hardness test on asphalts. A new needle of standard dimensions has been devised and several laboratories are to make comparisons of these with the old needles on a wide range of materials.

Marine Glues.

The Bureau of Construction and Repair of the Navy Yard and the Naval Aircraft Factory at Philadelphia requested of the Bureau information relative to marine glues for use in pontoon construction for hydroaeroplanes, and advised that the marine glue used most by them was an article of foreign source and could not now be had. It may be said that marine glues are not glue, but waterproof cements. An extended study of materials on the market was made and a report rendered to the above-named branches of the military service. Work is continuing on these materials, as new ones are continually being submitted to the Bureau for test.

Coke-Oven Process.

The Chemistry Division detailed members of its staff to assist in a test of a new type of coke oven at Canal Dover, Ohio, and is continuing to check the scrubber efficiency, to test the by-products obtained from this oven, and to make numerous other chemical determinations that were found to be necessary. Plans are being made for investigational work on the light oil and its derivatives—benzol, toluol, and solvent naphtha—that accrue from the operation of this oven.

Protective Coatings for Concrete Ships.

The Concrete Division of the United States Shipping Board placed before the Bureau the problem of developing satisfactory coatings for inside and outside surfaces of concrete ships, both cargo ships of the usual type and oil tankers. This means the development

of oil and waterproof materials of such a nature that they are procurable in sufficient quantities. A representative of the Shipping Board is cooperating at the Bureau in this work.

PAINT, VARNISH, AND SOAP.

(Chemical analysis, testing, and exposure tests of paint and varnish; chemical analysis and specifications for soap.)

Paint and Varnish Specifications.

The Chemistry Division has done a great deal of work in preparing and assisting in preparing specifications for a wide variety of paints and varnishes for various purposes, as follows:

For the United States Shipping Board: Inside white paint, outside slate-color paint, boot topping paint, copper bottom paint and varnish for wooden ships, anticorrosive bottom paint, antifouling bottom paint, hand-mixed red lead paint, ready-mixed red lead paint, bituminous solutions and bituminous enamels.

For the Navy Department: Enamels for airplanes.

For the War Department: "Paint specifications" (this in cooperation with the War Service Committee of the Paint Industry), air-drying and baking enamels for airplanes, shellac-rosin varnish for coating the interior of shells, shellac or garnet lac, and helmet paint.

A specification for airplane spar varnish prepared by the Bureau a year or more ago for the Signal Service of the War Department has been tested by both laboratory and exposure tests. The original specification has met with very general approval by practically every other consuming agency of the Government—International Aircraft Board, Bureau of Construction and Repair of the Navy, United States Shipping Board, several branches of the War Department, and the United States Railroad Administration. The specifications will secure satisfactory material at a low cost, and many manufacturers are now making varnish to comply with it.

Reports to the United States Railroad Administration gave summaries of the Bureau's work on linseed oil substitutes, for some of which extravagant claims are made. Most of them are thin-bodied varnishes with from 60 to 75 per cent of volatile matter. They may be successfully used in certain kinds of paint, but in considering their value as compared with linseed oil, it should be remembered that the non-volatile portion (25 to 50 per cent) should cost no more than raw linseed oil.

Fire-Retarding Paints.

Following a request from the Bureau of Yards and Docks, Navy Department, the subject of fire-retarding paints was taken under study and reported upon in November. Subsequent work tends only to confirm the conclusions of that report, which, briefly summarized, are as follows:

While practically all paint coatings have some fire-retarding action, none of the materials examined afford very great protection. All the samples tested were materially damaged by application of a flame for a few seconds. Both sodium silicate and whitewash rank relatively high. These have the advantage of cheapness and can both be used on the same surface. It is believed that, for interior wood surfaces, the application of sodium silicate solution followed by whitewash may be more efficacious than either one used alone.

However, no treatment of wood after erection can be expected to serve as an effective fire prevention, and the use of such materials should not be taken as an excuse for omitting any precautions tending to avert danger of fire starting or for providing ample facilities for stopping any fire as soon as it starts. Wood construction, no matter how the wood is treated, either before or after erection, involves serious fire risk. It is recommended that claims as to fire-retarding properties of paints be disregarded entirely, since practically all paints have some slight value in this respect and the difference between the best and the poorest is practically negligible.

Removing Metal Fouling from Rifle Barrels.

At the request of the Chief of Ordnance, War Department, a rather extended investigation was made of methods of removing cupro-nickel fouling from rifle barrels. What is believed to be a satisfactory preparation for ready use in the field was finally recommended.

ANALYTICAL METHODS AND STANDARD SAMPLES.

(General methods of chemical analysis, with special reference to methods of standardization; preparation and analysis of standard samples of iron and steel alloys, ores, chemicals, etc.)

Standard Analyzed Samples.

Another very great increase is shown in the demand for the Bureau's standard samples. A good part of this increase was occasioned by the general use of the samples by the Government and by private industries engaged in the manufacture of war material. The number of samples called for during the fiscal year 1918 was 4,836, as against 3,536 in 1917, 2,697 in 1916, and 1,826 in 1915. The distribution was as follows: Iron and steels, 3,674; brass, 80; ores, 357; sodium oxalate, 256; naphthalene, 85; benzoic acid, 44; sucrose, 69; dextrose, 13; metals for melting points, 221; cement for testing sieves, 37.

Three irons, 9 steels, and 2 ores are in process of preparation to replace exhausted stock. A considerable addition to the list of standard samples is now contemplated.

The granting by the present Congress of an appropriation of \$4,000 has served to place upon a more stable basis our work on standard samples, but the needs of the situation call for its increase to \$10,000.

It is of interest to know that private enterprise in England has made a beginning of providing standard samples for Great Britain. The preparation of the samples and the form of certificate issued are modeled with due recognition after the practice of this Bureau.

Determination of Tungsten and Molybdenum in Ores.

In cooperation with prominent analytical chemists in works, analytical firms and universities, the Bureau has carried on an investigation dealing with the methods of analysis for tungsten and molybdenum ores. As a result of this investigation tentative methods of analysis have been proposed and limited analyzed samples of several ores are available for special use. This work has now been extended to include metallurgical products of tungsten and molybdenum all of which are of much importance for military as well as nonmilitary uses.

6. ENGINEERING RESEARCH AND TESTING.

[Operative efficiency of mechanical appliances, accuracy of engineering instruments, conditions affecting their effective use, e. g., structure and design as related to durability and efficiency; methods of standardization and tests, standards of performance and fundamental researches on the scientific principles involved in speedometers, pressure gauges, water-current meters, anemometers, tachometers, gasoline and other motors, propellers, and other airplane parts and materials, etc.]

Theory of Measuring Instruments.

An exhaustive study has been made of the causes which produce variations apart from the so-called errors of calibration, in the readings of engineering and scientific instruments. The differences from exact reading, commonly known as calibration errors, are not seriously detrimental in the use of instruments, since they can be corrected by simple calculation; another class of errors which may be termed "variance" is disclosed in inconsistencies or deviations of the instrument reading when successive, identical values of the quantity being measured are applied. Such variations from constancy of reading at a given repeated value of the quantity undergoing measurement are not normally allowed for in the calibration of an instrument and means were not hitherto available for general correction of observations for such errors. A detailed discussion of the causes and results of the variance type of errors has been developed by a member of the staff and a paper is in press covering the subject, which is one of great interest to designers and technical users of measuring instruments of many and diverse sorts. The results obtained promise to be of such importance and of such direct application to many of the types of instruments employed in military uses that the continuation of the work will be provided for as actively as the requirements of other projects permit.

Routine Tests of Instruments and Devices.

Calibrations were made of 218 current meters, 60 high-pressure gauges, 66 other pressure gauges, 23 paper testers, 3 anemometers, and 6 water meters. Miscellaneous tests of instruments and devices, including safety valves, condenser tubes, speedometers, gauge glasses, indicator springs, etc., numbered 84.

Tests were made also of powder containers, samples of cast-iron shells, high-pressure flexible metallic tubing, tachometer shafts, odometers, and the like for the various divisions of the Army.

MISCELLANEOUS MILITARY TESTS OF DEVICES AND EQUIPMENT.

Numerous tests of this character were made, including tests of powder containers, samples of cast-iron shells, high-pressure flexible metallic tubing, tachometer shafts, odometers, and the like, for the various divisions of the Army.

MECHANICAL APPLIANCES.

(Investigation and calibration of special mechanical appliances; development of methods and apparatus for standardizing the performance of such appliances; investigation of the operative efficiency of mechanical appliances, such as fire extinguishers, radiator traps, vacuum cleaners, and the like.)

Fire-Extinguisher Investigations and Tests.

The investigation of hand chemical fire extinguishers for the Steamboat Inspection Service has been continued. Tests are being

made and reports submitted to the Board of Supervising Inspections of Steam Vessels of such extinguishers as are being submitted to that board for inclusion in its list of extinguishers approved for use in vessels under its jurisdiction. The number of extinguishers tested during the year was 41, including those submitted for the first time and those previously rejected and again submitted after redesign.

As a result of these investigations a great mass of test data has been accumulated which proved to be of the most vital value to the Government in the present emergency. When it was found necessary to purchase several hundred thousand extinguishers of the carbon tetrachloride type for airplane, motor truck, and similar service, test data were already available relative to most of the machines of this character on the market and these data have been supplied to the fullest extent for the information of the various offices of the Army and Navy interested in the purchase of these devices.

At the request of the Bureau of Construction and Repair, a comparative test of a number of designs of tetrachloride extinguishers selected by that bureau has been undertaken to establish an approved list for the purchase of such devices.

A series of fire tests was made of extinguishers of the so-called dry-powder type, which demonstrated their comparative inefficiency as a first aid fire appliance.

Tests of Airplane Equipment.

To assist the Signal Corps in securing suitable equipment numerous tests were made for the Army of high-pressure oxygen tanks and valves.

Comparative Test of Roof Ventilators.

At the request of the Construction Division of the Army tests were undertaken at the end of the present fiscal year to determine the relative efficiency of a large number of roof ventilators to be purchased by that division for use on Army cantonment and hospital buildings. A report of the results of this work will shortly be made.

Thermostatic Valves for Vacuum Heating Systems.

The investigation of thermostatic radiator valves for vacuum heating systems for the office of the Supervising Architect of the Treasury Department has been continued, to include the new devices of this character submitted to that office in connection with buildings under its control. The efficient and economical operation of a vacuum system is principally dependent on the successful operation of these valves, one of which is connected to each radiator outlet. Tests are made under working conditions to determine if these devices are successful in keeping the radiator up to the temperature of the steam supplied, by the continuous removal of air and water, without permitting the wasting of uncondensed steam to the return line.

Performance and economy test data have been obtained on all the leading brands of such valves. The data obtained have been furnished the Construction Division of the Army for use in the selection of the best type of equipment for the new cantonment, hospital, and office buildings which have been and are being constructed.

ENGINEERING INSTRUMENTS.

(Investigation and calibration of engineering instruments; testing of water-current meters, water meters, high and low pressure gauges, speedometers, anemometers, and tachometers; researches on problems affecting the precision of operation of such instruments, including standards of performance.)

Water-Current Meter-Rating Station.

One of the most important engineering services rendered by the Bureau is the furnishing of accurate calibration of current meters. These instruments are used by civil hydraulic engineers in the measurement of the velocity of flowing water in rivers, irrigation canals, and other open channels, to secure data for the computation of the quantity of water discharged through such channels in a given time, such data being essential in the development of the water resources of the country in power projects, irrigation, flood prevention, and similar projects. To secure accuracy in these measurements, the instruments must be carefully calibrated from time to time. A body of still water must be available for this purpose, together with equipment for towing the instrument through the water at different uniform speeds and for accurately recording the observations.

Adequate installations of this character are costly and are necessarily confined almost entirely to Government stations and large university laboratories, and the latter are not always available for this purpose. In the new rating station designed and constructed by the Bureau especially for this work, exceptional facilities are afforded for the calibration and study of these instruments. The entire flume is housed over and the station is in continuous operation throughout the year. While a majority of the ratings made are for the different engineering bureaus of the Government, this service is also performed for engineers in private practice, a rating curve and table being furnished for a nominal fee.

During the fiscal year 218 current-meter calibrations were made. A series of tests were made to determine the characteristics of a new type of screw-operated current-meter recently developed by an instrument manufacturer. Two current meter ratings were made for the Colonial Department of the Government of the Netherlands.

Current-Meter Investigations.

While the routine calibration of current meters has been continued without interruption, the investigations having for their object the study of problems relating to their characteristics and use have necessarily been suspended during the period of the war in favor of work of a military nature. One investigation, however, made during the previous fiscal year for the United States Geological Survey to determine the variation from the normal meter rating caused by the use of various arrangements of standard weights suspended with the meter on a cable was extended to include certain new equipment recently adopted. When velocity measurements in deep stream are made, such accessories are employed to maintain an approximately vertical alignment of the cable. The series of conversion factors has now been completed, permitting conversion of the standard rating table and application to all arrangements of meter and weights ordinarily used in the field. This renders unnecessary a separate calibration of the meter in each case.

A circular has been issued by the Geological Survey to its field engineers tabulating these data for their use.

High-Pressure Gauges.

During the past fiscal year calibrations were made of 60 gauges intended for the measurement of pressures ranging from 1,000 to 30,000 pounds per square inch. Included in this number are the instruments tested for the Government inspectors of the Ordnance Department for use in the testing of munitions, and for the manufacture of munitions and of gauges. On several occasions calibrated instruments have been furnished to offices in the War Department for the purpose of special tests.

High-Pressure Oxygen Gauges.

For a branch of the Army tests were made on different makes of small gauges for use on high-pressure oxygen apparatus. This work included a study of instruments developed to meet the peculiar conditions encountered in this service, for the purpose of formulating specifications as well as acceptance tests of production samples.

AERONAUTIC INSTRUMENTS.

(Investigation and testing of all types of aircraft instruments, including altitude-measuring instruments, engine speed and air speed indicators, airplane pressure gauges, inclinometers, gasoline depth gauges, mercurial barometers, weather and surveying aneroids, sphygmomanometers, oxygen control apparatus, bomb sights, and rate of climb indicators; development of methods of testing, improvement of design of such instruments, fundamental researches on underlying principles of such instruments, study of the operation in actual service, provision of the numerical data required in their use.)

After the war began, the general scope of the Bureau's work on airplane instruments was expanded to include practically all types of aviation instruments. Investigations were begun in this and other sections of the Bureau of practically every type under simulated service conditions, and with accelerated tests under exaggerated conditions. Such instruments as used in the modern airplane include the altimeter for indicating height above ground, compass for indicating north, inclinometer for indicating the angle of the plane with respect to the horizon, airspeed indicators for relative speed of plane and the air, tachometers for showing revolutions of engine shaft, special nonfluid thermometers, pressure gauges for the engine, gasoline level indicators, timepieces, oxygen control apparatus, staticscope to show whether the aircraft is rising or descending, range finders, angle-of-attack indicators, and the like. The prompt, reliable readings of these instruments are vital to successful aircraft control upon which depends the accurate control of gunfire, the mapping of enemy positions and movements, as well as the efficiency of action of bombing and fighting planes.

The Bureau has collected examples of the typical French, English, and American aviation instruments, as well as of German instruments captured by the French. All available data regarding the construction and use of the various instruments has been placed at the disposal of manufacturers and interested officers of the War and Navy Departments.

An important part of the work of the Aeronautic Instrument Section has been the instruction of inspectors in the Bureau of Aircraft Production in the testing of the instruments which they are to inspect at the factories for Army and Navy use.

A series of technical circulars has been prepared discussing the principles involved in the various aeronautic instruments and the methods of testing employed at this Bureau. These circulars are for the instruction of the experts engaged in aviation work. Large num-

bers of these circulars are called for by the technical divisions of the Army and the Navy.

A series of lectures was conducted for a group of naval aviation officers on the principles of operation and methods of testing the different aeronautic instruments. Plans are under way to complete this course, with extensions to other groups of naval and Army officers.

Oxygen Control Apparatus.

The oxygen control apparatus is of special interest in view of its vital relation to the physical condition of the aviator at high altitudes. At higher levels the aviator must have artificial sources of oxygen, and these must be of known and assured reliability. The apparatus delivers oxygen in amounts which are regulated by an aneroid control valve, so that the amount of oxygen delivered is correct for each altitude. The performance of the entire device is being investigated in the aviation instrument laboratories of the Bureau. The Bureau has studied the effect of the variations in temperature upon the accuracy of the action of these instruments, and has also made suggestions looking to the removal of defects and improvement of operation.

Statoscope Design.

A serious defect in the existing design of the statoscope was discovered. The statoscope is used to indicate with extreme sensitiveness whether a balloon or aircraft is ascending or descending. The Bureau's knowledge of the technical points involved in airspeed indicator design enabled it greatly to assist the American manufacturers in improving the quality and quantity production of such instruments.

Barographs.

An interesting and important development devised at the Bureau extends the range of barographs so that they will operate at higher altitudes than the instruments were constructed to encounter. The Bureau has also devised an electrical spark method of recording graphically the changes in pressure which indicate the altitude of aircraft.

The Bureau has computed new pressure altitude tables covering all heights up to 35,000 feet. These have been duplicated and furnished to the military officials concerned. The Bureau has also computed tables of temperature corrections to these tables to correct the variations in readings of barometric devices caused by temperature fluctuations. Tables of data such as those mentioned will greatly aid in the accurate location of position in the air with a view to due allowance for altitude in bomb dropping and for other purposes.

Airplane Thermometers.

The Bureau suggested sometime ago to the manufacturers of thermometers the making up of airplane thermometers of the pointer-and-dial type, operated by vapor pressure. Some of these were made up in the factories and submitted to the Bureau of Standards for complete test. The results were gratifying and it was shown that the new instruments possessed marked advantages over those previously manufactured. For high altitudes, the ordinary thermometers would not be usable on account of the freezing of the mercury.

Testing and Investigation of Aeronautic Instruments.

An important aspect of the Bureau's researches on aeronautic instruments has been the provision of laboratory facilities whereby the

conditions at high altitudes could be simulated—for example, the pressure, temperature, and the vibration peculiar to airplanes, in order that the behavior of measuring instruments might be accurately studied under conditions found at any and all altitudes and conditions likely to be encountered in flight.

In testing the aeronautic instruments a special temperature chamber was constructed provided with cooling coil, fan, and heater for controlling the temperature within the inclosure. Aviation instruments are placed in the chamber to determine the error resulting from temperature changes experienced in airplane flight. The apparatus was found perfectly adapted to test thermographs—self-recording thermometers for recording changes in the air temperature during airplane flights. While the data provided by the Bureau cover altitudes beyond those ordinarily used in military operations—in some cases altitudes of 40,000 feet—the rapid progress in aviation makes it desirable to anticipate the possible developments of the near future.

Aeronautic instruments, including a newly designed pressure gauge and valves for high-pressure cylinders, have been tested at very low temperatures. A low temperature comparator was built for tests of oxygen cylinders at low temperatures, high pressures, and with mechanical vibration—to get conditions encountered in high altitude airplane flights.

AERODYNAMICS.

(Measurement of the resistance of the air to the motion of bodies relative to it, including the determination of the magnitude, direction and point of application of the resultant force, and its relation to the relative speed; study of the aerodynamical properties of airplane wing models, stability of model airplanes, efficiency of propellers and wind motors, characteristics of air bombs, and testing of airplane equipment and other apparatus functioning in an airstream.)

Wind Tunnel Investigations.

The construction of the Bureau's new wind tunnel building was undertaken in September, 1917, and completed, including the installation and operation of the wind tunnel, in January, 1918. The room housing the tunnel is 70 feet long, 29 feet wide, and 18 feet high, with a self-supporting roof. The building contains in addition a small shop, a computing room, and a drafting room on the mezzanine floor above these.

The wind tunnel is of the open type, octagonal in cross section, the distance between opposite faces of the octagon being 54 inches. The straight portion of the tunnel is of wood, supported by a structural-iron framework. The entrance and exit cones are constructed of the cotton cloth used for covering airplanes, doped and varnished, and supported on an open steel and wood framework. The wind stream is maintained by a tractor propeller 9 feet in diameter, mounted directly upon the shaft of a 100-horsepower direct-current motor. An air speed of 90 miles per hour is attained with an expenditure of about 85 electrical horsepower.

The tunnel is equipped with two weighing balances, so arranged that either can be used independently of the other, but not, of course, simultaneously. One balance is of very heavy construction, designed to carry heavy models, such as air bombs and engine radiator sections, and is adapted for lift and drift measurements only. The other balance, which is a modification of the National Physical Laboratory type, is designed primarily for the investigation of the characteristics of airfoils and airplane models. The measurement of the moment from which is determined the center of pressure of

the airfoil is made by means of an auxiliary balance connected with the moving member of the main balance in such a manner that it is possible to measure lift, drift, and moment simultaneously.

The wind tunnel, since its completion, has been devoted almost entirely to work of a military nature, including tests of airfoils, models of airplanes and dirigibles; tests and calibration of air-speed indicators of the Pitot, Venturi, and combination Pitot-Venturi types; investigation of propellers for driving the generators used in aeronautic radio signaling, to the end of developing a constant speed propeller; testing bomb-dropping devices and determining the characteristics of aerial bombs in the wind stream; investigating the head resistance of a large number of radiator sections; and other work of a similar character for both the Army and the Navy. In addition, cooperation has been afforded another division of the Bureau in making an extensive investigation for the Quartermaster's Department of the efficiency of various types of ventilators.

The tunnel has also been used in an investigation of wind stresses on power lines and telephone and telegraph wires under conditions in which the wind resistance is increased by a coating of ice on the wire.

Free-Flight Investigations.

The purpose of the work has been to develop the instruments and methods which will make it possible to secure continuous autographic records of the performance of an airplane and its power plant during a free flight of the airplane under the normal operating conditions. The quantities which it is most important to record autographically are: The torque and revolutions per minute of the engine, the thrust of the propeller, the speed of the airplane with reference to the air, and the angle of incidence of the wings and their inclination referred to the true horizon. The measurement of these quantities on a full-sized airplane in free flight would furnish the ultimate test of the theories on which airplanes are designed. It would add greatly to the value of all the laboratory studies of airplanes and their engines which are now being made, by showing what corrections must be made to the direct conclusions from such studies to fit them to the actual conditions under which full-sized airplanes operate.

During the year all 6 of the new autographic instruments desired have been designed. The construction of the torque meter, of the thrust meter, and of the angle of incidence meter have been completed and these instruments are now awaiting laboratory tests and calibration. The airspeed meter is nearly completed.

The instrument for determining the inclination of the wing chord, known as the Bureau of Standards stable zenith, has been subjected to extensive tests, which have demonstrated that it will serve its purpose in the air with a much higher degree of accuracy than any other known instrument. This instrument combines two gyroscopes in a novel manner which secures a great gain in accuracy and in adaptability to various conditions. It is believed that out of the instrument there will be developed in due time a group of new gyroscope instruments adapted to various uses.

All of the above work described in this section has been done in close cooperation with the National Advisory Committee for Aeronautics.

7. STRUCTURAL, MISCELLANEOUS, AND ENGINEERING MATERIALS.

[Investigation of properties, use, fabrication, and design of structural, miscellaneous, and engineering materials; development of specifications covering the use of such materials; improvement of processes of manufacture; improving present and developing new methods of testing; development of testing apparatus.]

METALS.

(Development of airplane design, including structures, and appurtenances and discovery of suitable materials for construction purposes, especially metal construction; investigation of processes for kiln-drying of timber; design and calibration of airplane flight recording instruments; welding research for ship construction; calibration of testing machines and extensometers; standardization of hardness testing with various machines; determination of the physical properties of metals, woods, molded materials, and rope.)

Investigation of Metal Airplane Beams.

Extensive experiments have been made this year on sheet steel and aluminium alloy as a possible substitute for spruce in airplane structure. The resisting moment of the present spruce spar was computed, and possible sections formed of sheet steel and alminum alloy were compared for resisting moments and weights per linear foot. Specimen metal beams were also tested to failure. In these tests aluminium was found to offer the best prospects.

Extensive experimental work was carried on in cooperation with a metal company at College Point, N. Y., which made metal parts from designs furnished by a member of the Bureau staff. This member of the staff spent several months at College Point supervising the work in person. Steel and aluminum alloy were used and it was found that cold-rolled steel beams had only about one-half the strength of wood. Aluminum gave more promising results, and was used for the beams of two sets of Curtiss JN-4B wings, whose ribs, ailerons, and other parts were of steel. Flights totaling about 60 hours were made in an airplane equipped with these wings at McCook Field, Dayton, Ohio, and no deterioration in their structure was found. Sand-loading tests of the flown wings, and of duplicate new wings gave a factor nearly the same as that obtained with a set of Curtiss wood wings.

Heat-treated steel beams were tested under combined bending and axial load to determine their strength. A rough test on beams heat-treated in this manner showed a high modulus of rupture. Judging from these tests the heat-treated steel beams have the same strength as the wood beams.

Other aluminum alloys, one of which contained silver and copper, were tested in tension and bending to determine their suitability as a material for airplane construction. Tests showed that these materials were not as favorable as other materials procurable. All of the data obtained from these experiments have been embodied in the "Report on Steel Construction" for the Advisory Committee for Aeronautics.

Substitutes for Spruce in Airplane Construction.

In an endeavor to find suitable substitutes for spruce in airplane construction, numerous tests were made on the following woods: Cypress, fir, juniper, gum, redwood, tanwood, cuban wood, oak, ash, mahogany, pine, balsa, majagua, tupelo, Spanish cedar, Brazilian

walnut, and California spruce. In general, the tests showed that cypress and Douglas fir offered the best possibilities. Balsa wood proved to be very light, soft, and elastic, but of a lower specific strength than woods now used for airplane construction. Spanish cedar was also found to be satisfactory from the point of weight and uniformity of structure, but low in strength compared with other available woods. On the other hand, tupelo wood was found to be excessive in weight as well as deficient in strength, while Brazilian walnut proved to be rather heavy but of correspondingly high strength. Short-leaf pine from Arkansas was found favorable, while majagua wood proved, under tests, to be unreliable and inconsistent, due apparently to the irregularity of the sap and heartwood. As a rule specimens showing a large percentage of sapwood proved to be the stronger.

Investigation of Mahogany for Airplane Propellers.

Several kinds of mahogany were subjected to expansion tests, after their moisture content had been reduced to zero by oven-drying, to obtain information as to probable distortion or warping of airplane propellers, the present construction of which is largely of that wood. After first reducing the moisture contents of these specimens to zero by oven-drying, they were exposed to air for different lengths of time and the expansion measured. Further tests were made by exposing the specimens to an atmosphere of high humidity. All the species tested were affected about equally by given changes in the moisture content, but the true mahogany absorbed moisture much more slowly than the other varieties.

Investigations of the Effects of Kiln-Drying Spruce.

The investigation started last year to discover the effect of kiln-drying on spruce to be used for airplane manufacture has been continued this year. A member of the department visited several places where kiln or other methods of drying were used. The methods studied involved the drying of cypress and Port Orford cedar as well as Eastern and Western spruce. While all the methods were not equally satisfactory, and it was necessary to compare the cypress and cedar with data collected from air-dried spruce, due to lack of data on air-dried cypress and cedar, the general conclusion was that, with improvements of the process, artificially dried wood would prove just as satisfactory as air-dried:

Airplane Strut Investigation.

This investigation, inaugurated some time ago for the determination of proper strut formulæ for airplane design, was progressed to the completion of tests on struts ranging from 24 to 255 L/R with both square and round ends. The results of the investigation have been prepared for formal publication as one of the contributions of the Bureau of Standards to the work of the National Advisory Committee for Aeronautics. A number of typewritten copies have been made to supply any demands that may be received before the publication is completed.

Aluminum latticed and veneer spruce struts have also been tested and a report made on the former. One of the 30-foot aluminum

girders was tested with a uniform transverse loading and direct axial compression. This girder was also tested supported at one-third points to duplicate service conditions and the ultimate compression load recorded.

Airplane Thrust and Torque Dynamometers.

Much of the time of one member of the division was spent on the detailing of thrust and torque meters for determining engine performance under flight condition. Detail drawings of the torque dynamometer were prepared under the supervision of this division. The completed drawings were sent to the shop and the instrument has been completed, except for minor details.

A thrust dynamometer was calibrated under static and dynamic conditions for the Bureau of Steam Engineering of the Navy Department.

Instrument for Measuring Tension in Airplane Cables.

The "tensiometer," an instrument for measuring of the loads on airplane cables, was designed by a member of this division and made in the division shop. This instrument, after being successfully tried out and calibrated, was submitted to the Navy Department for inspection and was reported on favorably by them.

Shock-Absorbing Wheels for Airplanes.

Tests were made in radial compression and side thrust on two wheels designed to substitute spring rods for radial spokes, and also to put sheet-metal cases in place of pneumatic tires in obtaining the required resiliency. These tests revealed certain defects in design which were corrected by the manufacturer, and tests on the corrected wheels showed them to be about 30 per cent stronger in resisting side thrust. These proved stronger in side thrust and weaker in radial compression, but did not prove as stiff as the wheels with the original hub construction.

Investigation of Magneto Couplings for Airplane Use.

Three magneto couplings were investigated for the Signal Corps to determine their suitability for airplane use. They were tested for mechanical strength and for durability of the flexible rubber connections, and were found to be satisfactory.

Sea-Plane Tail Booms.

Tests were made on 4 hollow spruce tail booms of two different sections and weights but of the same length. The larger sectioned boom was only 20 per cent heavier, but 60 per cent stronger.

Metal Wheels for Motor Trucks.

An investigation as to the suitability of metal wheels for motor trucks was undertaken for the Quartermaster's Department of the Army. These wheels were tested to destruction in radial compression and side thrust. A Government design of composite wheel, also tested, was found to be superior in some respects. Tests were made on two composite cast steel wheels and two pressed steel wheels which differed from the wheels previously tested by having web spokes and a brake drum cast as an integral part of the wheel. Reports on

these tests were sent to the Quartermaster's Department, Ordnance Department, and the Signal Corps.

Tests of Palmetto Wood for Sea-Faring Purposes.

A sample of palmetto wood was tested for water-excluding purposes at the request of the Bureau of Construction and Repair of the Navy Department. Oven-dried specimens were tested for the per cent of water absorbed in a given time, and compression tests were also made. Compressive and shear tests were made on specimens which had not been previously dried. The results obtained showed this wood to be exceedingly weak both in compression and shear.

Investigation on Failure of Steel Plate.

Tests on the steel plate which broke last June, under crane manipulation, at the Homestead Steel Works, have been completed. This investigation was attacked from the standpoint of internal stresses. Besides tensile tests, microscopic and chemical analyses were made, and the whole embodied in a report which was sent to the Bureau of Construction and Repair of the Navy Department.

Investigation of Electrically-Welded Plates.

Arc-welded sheets were tested for the Steamboat-Inspection Service to determine their availability for lifeboat construction. Tension tests showed the arc welds to be 100 per cent efficient. Alternating stress tests showed that the welded section was not injured appreciably during the process of welding.

An investigation of spot-welded top joints proposed for airplane construction was inaugurated to determine the efficiency of the welds. Certain drilled and rectangular tubular sections were also tested in cross bend and tension to determine their relative efficiency for this purpose.

Investigation as to Cause of Failure of Bearing Plates and Rollers.

Two bearing plates and 5 rollers from the thrust bearing of the turbo-generator units of the Gatun hydroelectric station, submitted by the Panama Canal, were investigated for cause of failure. The failure of one of the bearing plates was found to be due to quenching cracks, while the second one failed from abrasion of the surface; the rollers in this instance being harder than the plates. The heat treatment required to produce the necessary hardness and still not develop quenching cracks was ascertained.

Investigation of Floor Stress in the New Arlington Building.

Strain gauge measurements on the reinforced concrete floor slabs of this building were taken for the Treasury Department. All the field work has been completed and the data and conclusions are being prepared for a complete report.

Machine-Tool Investigation.

The investigation inaugurated last year in cooperation with the Research Committee of the American Society of Mechanical Engineers on the cutting action of machine tools was continued this year. A cutting tool of the De Leeuw type was designed and drawn

in detail and the library searched for literature of value in this connection.

Report on Extensometers.

Two well-known types of extensometer were attached to the same specimens in tandem and data for stress strain diagrams were obtained. Comparison of this data showed that the one instrument, although more convenient to use, has not the precision of the other. It can be used to advantage in obtaining the elastic limit and the yield point, but not for precise determinations of the modulus of elasticity where set measurements are necessary.

Adaptability of Scleroscope for Testing Rubber.

An investigation was made as to the adaptability of the scleroscope numeral as an index in determining the physical properties of solid rubber tires. A certain degree of proportionality was found to exist in using this numeral in predicting physical properties. The similarity of this test with the Whitney rebound test, already established in rubber testing, was pointed out in the report made.

Depth-Measuring Appliance for Brinell Hardness Machine.

An instrument company supplied the Bureau with a depth-measuring attachment to be used with the Brinell hardness testing machine. This instrument is being tried and the relation between depth and diameter measurements for hardness will be worked on with the object of determining a conversion factor.

Brinell Meter Investigation.

An investigation was made of a Brinell meter submitted by the Boston Navy Yard for the purpose of obtaining the Bureau's opinion as to its value. This was accomplished by tests made on standard bars and specimens with the Brinell meter and the regular Brinell machine. The object of the investigation was to determine the relative precision of these instruments, standardize the practice, and to facilitate the tests for hardness in munition plants. Considerable data were gathered as to the comparison of hardness numerals obtained with the Brinell meter and with the Universal Brinell machine. The report on the investigation recommends the Brinell meter, if a variation in Brinell hardness numerals to plus or minus 5 per cent is permissible.

Calibration of Testing Machines.

A number of calibrations (both direct and by comparison) have been made this year by the department. Besides calibrations of the Bureau machines, 9 machines with capacities ranging from 60,000 to 300,000 pounds have been tested by means of the Emery-rating levers. A great many more have been calibrated by means of calibration bars.

Considerable work was done in connection with a comparison test of the 800,000-pound chain tester at the Boston Navy Yard with the large Emery machine at the Bureau. This necessitated the designing of an outfit to obtain a comparison of the tension and compression supports of the large Emery. Certain changes in the design of this apparatus have also been made as to capacity and recording device,

such that the work of calibrating commercial testing machines may be accomplished with it. The machine work for this is under way in our shops. The original design of a hydraulic capsule has been revised to adopt it to calibration of testing machines up to 500,000 pounds capacity. The revision consists mainly of a multiplying system of diaphragms and suitable scale beams for weighing the applied load.

Investigation of Galvanized Wire to Determine Loss of Ductility.

The investigation undertaken last year for a steel and wire mill to determine the reason for loss of ductility in wire due to galvanizing was completed this year. Four types of coated rods—"rust-resisting" black finish, Lohmann lead-coated, Meaker electroplated, and Parker rustproof—were tested for another firm, and 6—copper cyanide, sherardized zinc, cyanide, pickled, shot-blasted, and zinc sulphate—for another. These specimens were heat-treated and then given tension tests.

Investigation for Changes in Design on Specification of Materials Submitted by the War Department.

A number of tests have been made for the Ordnance and Quartermaster Departments and the Signal Corps, with the object of recommending changes in design or for determining specifications. Among these the following tests were the most important:

Electric butt-welds were investigated from a metallurgical, chemical, and physical standpoint and were found to be of a superior character.

Retard and safety springs employed in French detonating fuses and steel and bronze springs from French motor fuses were tested in accordance with French specifications, to determine the specifications for our departments.

An extract of existing specifications on manila rope was compiled to form a basis for new specifications to be submitted to the cordage manufacturers.

A fairly exhaustive report on the physical properties of bakelite, silicon-steel, Swedish iron, phosphor-bronze, German silver, spring steel, and woods was furnished the Electrical Engineering Section of the office of the Chief Signal Officer. The information was requested in connection with construction of insulators, magnet cores, armatures, yokes, contact and tension springs, as well as boxes and cases for field-signaling equipment. Reference to additional literature and recommended practice were also included.

To obtain information upon which to base specifications, many miscellaneous tests were made on bolts and nuts, turnbuckles, steel wire and cables, and sheet steel for gasoline tanks. The last two items comprised over 400 individual tests, which were made in our laboratories, in greater part, by members of the Signal Corps.

Three sets of piston rods for a 12-inch barbette carriage were tested in the large Emery testing machine. In no instance was the proof load sufficient to reach the yield point of the rods.

In addition to the usual tests made every year, a great variety of special tests have been made this year, for different branches of the

War Department. This work comprised tests on steel for naval guns, shovels and hoes, oak keel blocks for ships, transverse girders, a 150-ton floating crane, chrome-vanadium steel, magneto couplings, trench jacks, French airplane material, aluminum girders, veneer struts, piston rods, electric-welded wrought-iron bars, welding refrigeration pipe, Army knives, armor plate, wire cable clamps, loading of shells, wall boards, celluloid, wire rope, lock nuts, brazed joints, gas mask parts, electric-welded steel mesh for concrete reinforcement, mess spoons and forks, fuse parts, copper-covered wire cables, bakelite control pulleys for airplanes, copper-coated wood for airplane propellers, powder containers, vulcanized fiber, eye splices, strap ring bolts, coupons of boiler plate steel, belt fasteners, halter chains, welded steel rings, steam pipe insulators, insulated copper wire, axes, machetes, manganese-steel bars, cutter blades, nickel-steel tubing, specimens of verilite, elastic safety belt, leggings, belt buckles, Duff jacks, Simplex jacks, meter oxygen tanks, sash chain, zinc for battery tinning, ash and hickory trench spade handles, compression grease cups of sheet metal, bakelite insulations, powder containers, buttons for uniforms, etc.

Equipment.

During the year the following equipment has been added: Small Olsen transverse bending machine, capacity 10,000 pounds; constant-temperature electrical oven for determining the moisture content of woods; Erichsen machine for finding drawing properties of different sheet metals; Riehle extensometer; Brinell meter; Olsen impact machine, capacity 400 foot-pounds; Izod impact machine, capacity 120 foot-pounds; Charpy impact machine, capacity 60 kilogrammeters; Olsen testing machine, capacity 50,000 pounds; cross-bend testing machine for testing veneer boards and wall boards; improved Riehle extensometer; Olsen tension and compression machine, capacity 20,000 pounds; wire-testing machine, capacity 2,000 pounds; Upton-Lewis repeated stress machine; 6-rotary repeated stress machines for testing aluminum alloys and wood; Berry strain gauge for tests of concrete buildings; apparatus for calibrating extensometers and strain gauges; speed-reducing mechanism for the recording drum of the Upton-Lewis repeated stress machine; 2 new lathes; 4 cabinets for small instruments and tools.

Investigation of Brick Piers.

The investigation upon brick piers was completed during the past year and the report of results is now in press. This investigation was taken up in cooperation with the National Brick Manufacturers' Association. It includes compression tests of over 50 piers $2\frac{1}{2}$ by $2\frac{1}{2}$ feet in cross-section and 10 feet high, which were constructed of various grades of brick and mortar and with different types of bonding. The bricks were selected from 4 of the representative districts east of the Mississippi, so as to be typical of different manufacturing outputs. The brick were graded as to hardness according to the tentative specifications of the American Society for Testing Materials.

The following are the conclusions drawn from the results of tests: The strength of brick piers depends primarily on the quality of brick and kind of mortar used. Of the mortars used, the cement mortar develops about twice the strength of the lime mortars, or 2,700 and 1,400 pounds per square inch, respectively, for the highest grade of brick. The cement mortar is harder to work, however, and a combination lime and cement mortar which does not appreciably affect the strength of the piers is cheaper, and has much better working qualities. The combination used in the present investigation was 1 part of cement and lime (by volume 65 per cent and 35 per cent respectively) to 3 parts sand. The strength of piers laid in the combination cement and lime mortar was practically the same as those laid in a 1:3 cement mortar, giving twice the strength of those laid in 1:6 lime mortar and about four times the strength of those laid in 1:3 lime mortar. The type of bond as concerns the number of header courses used has little, if any, effect upon the ultimate compressive strength of the piers. The introduction of wire mesh in the horizontal joints adds strength if used in all the joints. This does not apply, however, if used in every third or fourth course only, and may even decrease the strength of the pier. The transverse, rather than compressive strength of the individual brick, is believed to bear the closer relation to the ultimate strength of brick masonry.

Investigation to Determine Bearing Power of Soils.

This investigation was taken up in cooperation with the American Society of Civil Engineers' committees on soils, and has been continued during the past year. The physical properties of different types of earths are determined by laboratory tests and the results compared with measurements made in the field. The field tests have shown that there is in many cases a considerable range of variation in the observed data, even when the tests are conducted under identical conditions, upon soils having the same structures, but at different observation points. These variations have been found to depend upon the relative densities of the earth, the character of the aggregate and binder, moisture content, and other variables. The laboratory tests have been conducted for the purpose of ascertaining the relative influence of the more important factors which control the bearing values of soils in relation to foundations and other engineering structures.

General Summary of Testing.

The following is a summary of the testing done in this division, and represents an increase of 50 per cent over the number of specimens tested during the previous year:

Tests for the Navy Department.

1. Bureau of Construction and Repair-----	175
2. Bureau of Yards and Docks-----	24
3. Other branches-----	49

Tests for the War Department.

1. Ordnance Department.....	344
2. Quartermaster's Department.....	113
3. Bureau of Aircraft Production.....	670
4. Engineering Department.....	145
5. Surgeon General's Office.....	10
Tests for the Panama Canal.....	147
Tests for the Department of Interior.....	12
Tests for Treasury Department.....	6

Tests for Department of Commerce.

1. Bureau of Standards.....	388
2. Other branches.....	6

Tests for United States Shipping Board.

1. Shipping Board.....	19
2. Emergency Fleet Corporation.....	36

Tests for the Post Office Department.....	1
Tests for National Advisory Committee for Aeronautics.....	52
Tests for private firms and individuals.....	793

Total.....	2,990
------------	-------

Calibration of Testing Machines.

It evidently comes within the work of this section to calibrate testing machines. Recently the materials-testing laboratories at both Worcester Polytechnic Institute and the Massachusetts Institute of Technology have requested very earnestly that some at least of their machines be calibrated by this Bureau.

They find this necessary because they are testing materials for acceptance under Government contracts.

It appears feasible to construct a machine for applying dead weights possibly up to 200,000 pounds. This could then be used to calibrate a tension bar or other apparatus for use in determining the error in any given testing machine.

The design of this machine is now being considered. Apparently its cost would be high, due to the present price of cast iron, which would be used for the weights.

New Equipment.

A large capacity testing machine for transverse tests upon beams and other engineering structures should be provided for the new laboratories in the Engineering Building.

A torsion machine of larger capacity and greater accuracy would also be desirable. It is evident that the equipment at present available for making transverse and torsion tests is much inferior to that provided for other work.

Considerable work has been done upon calibration of hardness apparatus of the Brinell type. It would be advantageous if a dead-weight machine of this type was provided by means of which the hardness of standard bars could be determined. If this work could be done rapidly and accurately at this Bureau, many manufacturers would submit samples of the metals they are using, for standardization.

Two special devices for calibrating extensometers were designed and built. One of these handles all types of extensometers that will go on a standard 0.505 inch diameter round specimen. The other device is for calibration of extensometers of the Berry strain gauge type. Both devices take instruments with any gauge length from 2 to 10 inches. A number of strain gauges and extensometers have been calibrated with these devices.

General Tests of Structural Materials.

A number of tests not classified in the reports of research have also been made for different departments of the Government and various manufacturers. These include 30 tests of manila rope in sizes up to 3 inches diameter, 52-wire rope in sizes up to 1½ inches diameter, 4 concrete columns of diameters 12 to 20 inches, 12 bridge rollers, 6 porcelain insulators 12 inches diameter for wireless towers, 7 tests of large chain links, 46 compression and modulus tests of porcelain, and a number of special tests of brick, tile, and steel bars. A number of special tests were made upon projectiles according to Government specifications.

The following tests were conducted for different departments of the Bureau of Standards: Compression tests on approximately 1,200 concrete cylinders 6 inches diameter, 640 tests on 2-inch cubes of cement, 360 tests of 2-inch cylinders of lime composition, 600 cylinders 2 inches diameter of floor cement, and 600 transverse tests of bars of floor cement.

Tests of Tile Walls.

A number of tests have been conducted on walls of tile varying in thickness from 6 inches up to 12 inches, in widths 3 to 6 feet, and 10 and 12 foot heights. The strength of the wall when tested in this manner varies from 200,000 up to 600,000 pounds or more, depending on the thickness of the walls, and the geographical district from which the tile was selected, some clays being superior to others for developing strengths. The tile are laid in some cases with the flues running vertically, which develops the greatest strength. Comparative tests are also being made with the flues laid horizontal. This does not give as great compressive strength, but the walls laid in this manner possess greater lateral stability.

These tests have been continued the present year. A great deal of interest has been manifested in the tests by manufacturers, Building Code Commission, and architects. It is believed the data will ultimately be of great value in devising equitable specifications covering this important material.

CEMENT, CONCRETE, STONE, GRAVEL, AND SAND.

(Investigation and testing of materials for construction purposes; development of new methods of testing; improvement of apparatus for testing; preparation of specifications covering structural materials; development of new uses for cement products; distribution of knowledge as to use of materials; design and fabrication.)

Investigation and Testing of Cement, Concrete, and Stone.

The work of the section during the year has been radically affected by war conditions. Several of the normal continuing investigations have been largely or wholly set aside by the continually increasing amount of emergency and special work, and the end of the year discloses a program almost entirely devoted to war service. Thus no

work has been done in connection with the investigation of the value of integral waterproofing compounds, the durability of concrete in alkali waters, nor upon the further development of the granular analyzer and air separator for cement, which were described in the last annual report. On the other hand, the routine inspection and testing of cement for the War and Navy Departments has increased to such an extent that a very considerable expansion in the Bureau's facilities for work of this character has been necessary, and still further expansion will be required in the immediate future. Special problems in the fabrication and adaptability of concrete for specific purposes and tests of a large variety of new or unusual concrete aggregates have occupied the entire time of an enlarged laboratory force. Considerable progress has also been made in the investigation of building stones, but less has been accomplished in this line of work than during the preceding year.

New Branch Laboratories at Denver and San Francisco.

At the beginning of the year the materials testing laboratories of the Reclamation Service at Denver and San Francisco were transferred to the Bureau, and were made immediately available for the work of all Government departments. As a result of the transfer the testing work at these points was increased to such an extent that, while all demands of the Reclamation Service were met, a much larger portion of the work, especially during the latter part of the year, was devoted to military and naval requirements. In the enlargement of the scope of the work at these laboratories it is intended to gradually make them available for broader and more general service, not only to the Government departments but also to the public, particularly for service which can not properly be performed by commercial or private laboratories.

Government Specification for Portland Cement.

The standard specification for Portland cement which became effective January 1, 1917, contained a clause to the effect that on and after July 1, 1918, the Government specification would require an increase in fineness, reducing the permissible residue on the standard No. 200 sieve from 22 per cent to 20 per cent by weight. At a meeting of the Departmental Cement Committee held April 2, 1918, the postponement of this requirement was discussed and eventually recommended in the adoption of the following resolution:

Moved, that the requirement for fineness of cement in the present specification, as follows: "The United States Government specification requires that on and after July 1, 1918, the residue on the 200-mesh sieve shall not exceed 20 per cent by weight," be changed to take effect six (6) months after the close of the war with Germany instead of July 1, 1918.

This recommendation was subsequently ratified by the Departmental Conference and approved by the heads of the several departments. The change becomes effective July 1, 1918, and all copies of Bureau of Standards Circular No. 33 (United States Government Specification for Portland Cement) issued after June 1, 1918, contain an insert announcing this change in the specification.

To avoid any misunderstanding of the Government's attitude regarding this change, it may be stated that the departmental committee in submitting its resolution expressed its unqualified belief in

the value of the increased fineness required in the specification. Upon representations from the War Industries Board, however, and in recognition of the conditions under which its invaluable service is being performed, the committee passed the resolution in order that no unnecessary friction might be encountered by the board due to additional restrictions upon the manufacture of cement in the midst of war activities.

Routine Inspection and Testing of Cement.

The tremendous expansion of military and naval activities during the year has been accompanied by a corresponding expansion in the construction programs of the War and Navy Departments, and the facilities of the Bureau have been taxed to the utmost in providing the inspection service required by the increased use of cement alone. The appropriations of the Bureau for testing structural materials have been entirely inadequate to cover the costs of this work, and its continuance throughout the year was made possible only by reimbursements from the War and Navy Departments and the Shipping Board. Furthermore, the shortage of available and experienced inspectors has been acute owing primarily to the fact that the salaries established for this class of employees are not attractive to men over the draft age. Nevertheless, the local boards have in the majority of cases appreciated the military value of this inspection service and have granted many of the Bureau's inspectors deferred classification, without which the work would inevitably have suffered.

During the fiscal year 1917-18 cement was inspected at 78 mills throughout the United States, as compared with 16 mills in 1916-17. The increased service which has been rendered during the past year is clearly shown in the following table, which contains the monthly shipments of cement inspected and tested by the Bureau during the 24 months from July, 1916, to June, 1918, inclusive:

Table Comparing Shipments of Tested Cement in 1916-1917 and 1917-1918.

Month.	Shipments of tested cement in barrels.	
	1916-1917	1917-1918
July.....	36,568	81,364
August.....	14,941	102,250
September.....	58,765	146,249
October.....	32,150	32,386
November.....	27,338	205,950
December.....	16,102	183,406
January.....	29,063	113,104
February.....	43,744	270,964
March.....	54,525	335,990
April.....	48,718	605,128
May.....	64,325	768,305
June.....	76,646	752,161
Total.....	502,885	3,597,354

These totals do not include 72,000 barrels of rejected cement in 1916-17 and 331,000 barrels of rejected cement in 1917-18. Rejections for 1917-18 were in fact larger than indicated, as records are not available of cement rejected by the commercial laboratories

acting under Bureau supervision. The total shipments for the past year include 168,731 barrels for the Panama Canal. Other State and Federal departments served were Commerce, War, Navy, Interior, Treasury, United States Shipping Board, Smithsonian Institution, District of Columbia, Massachusetts State, and various State highway commissions.

It will be observed that the shipments of tested cement during each of the last two months of the fiscal year 1918 were approximately one and one-half times the total for the entire preceding fiscal year. An increase of this magnitude in the inspection work has necessarily involved a large increase in the personnel and facilities for this work, and the organization of the service has been enlarged to cover all cement mills in the country. Thus the new branch laboratories in Denver and San Francisco have furnished inspection at the widely distributed mills west of the Mississippi River, the Pittsburgh branch has provided similar service at the mills in western Pennsylvania and the Ohio River district, the Northampton branch has served the New York and Lehigh (eastern Pennsylvania and New Jersey) districts, and the Washington laboratory has taken care of the Maryland and Virginia mills, as well as the overflow from the Lehigh district. Two well-known commercial laboratories have, under Bureau supervision, furnished inspection service at mills in the southeastern section of the country and also in the vicinity of Detroit, Chicago, and St. Louis.

The employment of these commercial laboratories to provide inspection service in those sections of the country where the Bureau has not yet established its own facilities has afforded an excellent opportunity to compare the costs to the Government of testing and inspecting cement as performed by its own laboratories and by outside laboratories. Assuming a sufficient volume of work to justify the maintenance of branch laboratories, the cost figures of the past year show that the Bureau laboratories are performing the required service at very approximately one-half the contract prices now being paid the commercial laboratories. The volume of work near the close of the year was such that the payments to these two agents was approximately equal to the cost of fully equipping a new branch cement testing laboratory each month.

Viewing the matter from still another angle, the saving which would accrue to the Government by its own cement testing through the Bureau of Standards rather than through commercial laboratories would vary from 1 to 2 cents for every barrel of cement so tested, the actual saving between these limits depending primarily on the percentage of full capacity at which the laboratories were operating. No more potent arguments can be advanced for adequate appropriations to establish the necessary Government branch laboratories in the cement-producing districts.

Another important point may be cited with reference to appropriations. The United States Railroad Administration has requested the Bureau to inspect and test cement for the railroads, an obviously advantageous and economical arrangement for the Government, since it permits the maintenance of pretested and certified stocks of cement ready for immediate shipments at every mill in the country. At the close of the fiscal year, however, no decision had been reached as to the manner in which this service should be pro-

vided for; but it is apparent that adequate appropriations for meeting these additional requirements are necessary before the facilities of the Bureau can be enlarged to the extent necessary for handling the large volume of railroad work.

Development of Testing Methods, Standardization of Testing Apparatus, etc.

Little progress has been made in the development of testing methods owing to pressure of routine work, efforts in this direction being limited to comparisons with the commercial laboratories of methods used and results obtained in the regular inspection work. It appears, however, that radical improvements in routine testing methods are greatly needed, and work of this nature must be undertaken at the earliest opportunity.

Some interesting preliminary work has been done in the calibration and comparison of testing machines. In the investigation work on building stones a very uniform sample of marble was discovered, from which a considerable number of test specimens were carefully prepared and submitted for compression tests to various laboratories. The range in results obtained on these specimens indicates a wide variation in the performance of testing machines, and the development of reliable calibration methods, particularly for large machines, is a problem requiring careful and urgent attention.

Investigation of the Value of Fine Grinding of Portland Cements.

The series of tests, started in 1916, to determine the effect of increased fineness on the cementing value of cement in mortar and concrete has been continued. The two year results show the same marked decrease in strength with the finer ground cements as did the tests of the previous year.

With knowledge of the general results of this investigation the Department of Concrete Ship Construction of the United States Shipping Board, Emergency Fleet Corporation, requested further comparative tests on various cements produced in the southern districts, both as normally ground and as reground to a fineness of 90 per cent passing the No. 200 mesh sieve. These cements were tested in 1:1:2, 1:1-1/2:3, and 1:2:4 concretes and in 1:2 mortar. In practically all cases the increase in compressive strength obtained with the finer cements was from 50 to 100 pounds per square inch for each per cent increase in fineness. From all the data obtained in this investigation the order of increase in strength which may be expected from finer grinding by ordinary methods is now fairly well established, and the question of requiring higher fineness in the standard specification for Portland cement is a purely economic one. There remains, however, the highly interesting and almost wholly unattacked problem of producing cements of much higher fineness than is possible by ordinary methods of grinding. It may confidently be expected that if practical methods can be found of reducing cement clinker to a very fine state of subdivision, a decided improvement in quality will result; to determine what degree of improvement may be obtained is properly the next step in this investigation. The importance of further progress along these lines is commensurate with the difficulties to be overcome in developing new methods of grinding, and concentrated effort will be required to deal

with the new problem effectively. Fortunately some progress was made before the war by the development of an air separator and an air analyzer for the production and mechanical analysis of very fine cements, to which reference was made in the last annual report. These devices will enable a good beginning to be made as soon as conditions permit, but the problem is of such magnitude that little progress can be hoped for during the period of the war.

Standard Cement Sieves.

Forty-three No. 200 sieves were standardized during the year. Owing to the fact that the scarcity of 200-mesh cloth is now acute, there is every prospect that the supply of high-grade cement testing sieves will be cut off entirely. The Bureau is already planning to use sieves for routine testing which do not conform to the standard specifications, and recommends that all users of cement sieves procure the standard fineness samples for the purpose of checking those sieves which are not certified prior to purchase. Even if the correction factors which may be obtained by the use of these samples are considerably in excess of those permitted in the standard specifications, it is believed that the corrected fineness determinations will be sufficiently reliable for mill control and routine testing.

Standard Fineness Samples.

The standard fineness samples of cement, prepared and issued by the Bureau to enable the users of cement sieves to check the performance of their own sieves, are furnished in two degrees of fineness: No. 46-d, of which 79.2 per cent passes the standard No. 200 sieve, and No. 47-b, of which 88 per cent passes the standard No. 200 sieve. These samples are issued in hermetically sealed glass jars, each containing approximately 160 grams of cement, and each is accompanied by full directions for use. In view of the present scarcity of good sieves, particularly of sieves conforming to the standard specifications, these samples should be more widely used.

During the year approximately 50 of these samples were used by the Bureau, 43 were sold at a nominal price to owners of No. 200 sieves, and 15 were donated for university work.

Durability of Stucco and Plaster.

The investigation of stucco and plaster, originally begun in 1911 and continued on a larger scale in 1915 and 1916, has included experimental work only in connection with the construction of three temporary testing laboratories erected on the Bureau grounds during the past year. In view of the present interest in housing problems it is unfortunate that greater progress could not have been made in the development of improved specifications for stucco, but important as this work undoubtedly is, it does not possess the essential and immediate value of the work which has necessarily displaced it. The most important contribution that could be made under the circumstances was the preparation and presentation of a paper at the annual meeting of the American Concrete Institute in June, 1918, giving a résumé of what has been accomplished in this investigation, and containing suggestions for the improvement of stucco based upon the results of experimental studies and field examinations already made.

Durability of Concrete in Sea Water.

In the early part of the year a comprehensive report was prepared and published in one of the leading technical periodicals on the condition of sea-water concrete structures along the coasts of the United States. This report was based on observations and studies made by representatives of the bureau and the Portland Cement Association during the preceding year, and was the forerunner of a more complete and detailed report to be published as one of the Bureau technologic papers dealing with this general subject. Unforeseen changes, however, and demands upon the time of those engaged in this investigation necessitated an indefinite postponement of the preparation of the final report.

Durability of Concrete in Alkali Waters.

This investigation, started in 1913, was undertaken primarily because of its importance to various branches of the Government using cements and concretes in irrigated districts and the arid regions of the West, where the alkali often becomes concentrated in the soil. The investigation, which is conducted in cooperation with the Reclamation Service, the Drainage Division of the Department of Agriculture, and the Portland Cement Association, has included the preparation of 8,000 specially prepared drain tile made in a commercial tile factory under the Bureau's supervision, and a larger number of concrete blocks using aggregates available for concrete in various parts of the West.

A progress report, Technologic Paper 95, issued in 1917, includes tests made in 1916 after a period of exposure of three years for the drain tile and one year for the concrete blocks. These results show that concrete and cement drain tile will disintegrate in some of these soils unless the best of materials are used and special care is exercised in fabrication.

Although this investigation is only fairly well started, no field work has been done since the fall of 1916, owing to other demands upon the time of those in charge. It is hoped that this work may be again resumed in the near future, as the problem of conserving concrete structures exposed to alkali waters becomes more important as time goes on and the magnitude of the investment in these structures increases.

Acceleration of the Hardening of Concrete.

As the result of some experiments made to develop a method to accelerate the rate at which concrete increases in strength with age, it was found that the addition of small quantities of calcium chloride to the mixing water gave the most effective results. A comprehensive series of tests was inaugurated to determine further the amount of acceleration in strength of concrete obtained in this manner, and to study the effect of such additions on the durability of concrete and the effect of the addition of this salt on the liability to corrosion of iron or steel embedded in mortar or concrete.

The results to date indicate that in concrete at the age of 2 or 3 days, the addition of calcium chloride up to 10 per cent by weight of water to the mixing water, results in an increase in strength over similar concrete gauged with plain water of from 30 to 100 per cent, the best results being obtained when the gauging water contains from 4 to 6 per cent calcium chloride.

Compressive strength tests of concretes gauged with water containing up to 10 per cent calcium chloride, at the age of 1 year, give no indication that the addition of this salt has had deleterious effect on the durability of the concrete.

Corrosion tests that have been completed indicate that the presence of calcium chloride, although the amount used is relatively small, in mortar slabs exposed to the weather cause appreciable corrosion of the metal within a year. This appears to indicate that calcium chloride should not be used in stuccos, and warns against the unrestricted use of this salt in reinforced concrete exposed to weather or water.

Moisture and Temperature Changes on Concrete.

Field work in this investigation has consisted of making strain gauge measurements on concrete roads and pavements to determine the change in volume of the concrete under changing moisture and temperature conditions, and to determine the most effective distance spacing of transverse joints in the slabs. The measurements show that the concrete follows a rather definite annual cycle of volumetric change. Laboratory work has consisted in measuring with a portable comparator the volumetric changes in cement mortars, plasters, and stuccos when they obtain their set and the progressive changes in volume as they age. A special apparatus for determining the absolute thermal coefficient of expansion of concretes and mortars has been designed and is in the course of construction; but work on the latter has had to be indefinitely postponed on account of the assignment of shop facilities to military requirements. A report on the work already accomplished is being prepared, but like most other reports unrelated to war work, it is necessarily shelved for long intervals.

Flat-Slab Floor Design.

At the request of the Bureau of Yards and Docks, Navy Department, a series of loading tests were inaugurated to determine the relative merit of three types of flat-slab floors designed for the purpose of procuring a suitable design to adopt as a standard for warehouse construction. The floors to be tested are in storehouses being built at the Submarine Base, New London, Conn.; Naval Operating Base, Hampton Roads, Va., and United States Navy Yard, Charleston, S. C.

The test procedure consists of loading 9 representative adjacent panels of each type floor with a superimposed load applied in regular increments until a maximum load is attained equal to twice the designed live load plus the dead load. As the load increments are applied, measurements are to be made with strain gauges to determine the stress in the reinforcing rods at 150 points and also the stress in the concrete at 150 points on both top and bottom surfaces of the floor. Deflections in the floor will also be determined at 41 points.

With the data obtained from these measurements, made when the concrete is 60 days old, a comparison can be made between the different designs of floor, which vary greatly in the amount of steel reinforcements used.

Floor and Roof Failures.

The advice of the Bureau has been sought in connection with a number of interesting cases of floor and roof failures.

The floor of the Pension Office at Washington is composed of clay tiles on a concrete base and has developed certain isolated areas in which the tiles have separated and warped away from the base to such an extent that they have broken down under traffic. Expansion measurements upon the flooring materials have been made, but no satisfactory explanation of the trouble has been found.

The floor of a dry dock at the Brooklyn Navy Yard has shown considerable disintegration. An investigation of this failure indicated that freezing and inadequate drainage were largely responsible for the trouble. A report is being prepared for the Navy Department embodying recommendations for repair of this structure.

The floor of the new Arlington Memorial amphitheater, which is composed of Vermont and Tennessee marble tiles, has shown a peculiar development of fine cracks in the Vermont marble. This case was reported just prior to the close of the fiscal year, and the investigation has not been completed.

The collapse of the steel truss and concrete roof of the Metropolitan Theater in Washington was partially investigated for the information that might be obtained. The immediate failure was found to be due to freezing of the concrete and premature removal of forms, although it was apparent that too small a factor of safety had been allowed in the design. The case also calls attention to the need for a more adequate system of building inspection.

Service Tests of Floors and Floor Treatments.

An abrasion machine has been designed and is in process of construction for the purpose of making wear tests on floors of concrete and other materials. The action of the machine is designed to simulate that of ordinary traffic. Progress in this work, however, has been so frequently interrupted, and so much difficulty has been experienced in procuring the component parts of the machine, that there is little prospect of completing the apparatus during the next fiscal year.

In the meantime a part of the program of this investigation is being carried out in the application of numerous concrete floor treatments to a large number of floor areas and panels in one of the new laboratories of the Bureau. These tests are qualitative and comparative only, but are actual service tests, and in the course of 2 or 3 years should yield valuable information. The majority of the treatments consist of the application of proprietary hardeners or dust preventives, together with a number of others that have been recommended by various investigators, for example, linseed oil, soap, water glass, etc. The scope of these tests also includes coverings of various sorts, linoleum, congoium, mastic coatings, etc.

Concrete Aggregates.

At the request of the department of concrete ship construction, United States Shipping Board, Emergency Fleet Corporation, a comprehensive series of tests was undertaken to develop or find a material that would produce a concrete of high strength and low weight per cubic foot. In this investigation the following materials

have been tested as aggregates in relatively strong mixtures: Crushed slags of different kinds; crushed clay tile, both hard and soft burned; crushed light brick of several varieties; a special hollow clay aggregate prepared by the ceramic division of the Bureau; a clinker produced by the rapid firing of clay or shale, coke breeze, pumice stone, vesicular basalt, and other volcanic, silicious, and calcareous rocks.

The most promising results were obtained with burned shale aggregates, which in the proportion of 1 part cement and 2 to 3 parts of graded shale yielded a concrete having a compressive strength of 4,000 pounds per square inch and a weight of less than 110 pounds per cubic foot.

A series of tests were also made on two blast-furnace slags, both as fine and coarse aggregate, from producers in Connecticut and Alabama. Aside from some difference in working quality the concrete and mortars from these materials were practically equal in strength to those obtained from sand, gravel, and stone of good quality.

Field Control of Concrete.

In connection with the concrete-ship investigations an apparatus has been designed to check the consistency of concrete in the field; that is, to control the amount of water required in mixing. This apparatus is essentially a piece of drawn tubing 6 inches in diameter and 12 inches long placed in a vertical position upon a horizontal plate. The tube is filled with the freshly mixed concrete and then mechanically lifted from the mass. The amount of settling of the unsupported concrete is a function of the amount of water used, and thus any predetermined consistency within the working limits can be maintained.

Also in the same connection a field testing machine for determining the transverse strength of concrete beams has been designed. The machine is simple in construction and can be easily set up on the site of the work for the purpose of determining the strength of beam specimens poured from the regular run concrete. Experiments with this device indicate that under given conditions a fairly definite ratio exists between the transverse strength and the compressive strength of concrete, and the latter can therefore be checked without resort to laboratory tests.

Effect of Reversal of Stress on Concrete Beams.

Few, if any, tests have been made on double reinforced concrete beams to ascertain the changes resulting from the reversal of stresses. With the advent of the reinforced concrete ship, a structure which must undergo changes of stress due to the hogging, sagging, rolling, etc., data of this nature has become of extreme importance.

A machine for applying loads in opposite directions to double reinforced concrete beams has been designed and the construction is 80 per cent complete. This machine consists of 3 units in order that owing to the long time required for making a test 3 beams can be tested at the same time. Considerable difficulty has been encountered in getting the machine to operate as it was intended, and a number of changes in the original design have been necessary.

Six beams have been made and 1 has been under test for several weeks, having undergone 300,000 reversals of stress. The beam under test is 8 feet 8 inches long, with a cross-section of 6 by 8 inches

and is reinforced with 3 $\frac{1}{2}$ -inch plain bars top and bottom, so placed as to give an effective depth of 6 inches. The applied load at the center of the beam is 5,000 pounds and the computed stresses according to the straight line deformation assumption are: Concrete, 2,000 pounds per square inch; tensile steel, 20,000 pounds per square inch, and compressive steel, 6,000 pounds per square inch. The strain gauge measurements taken on the steel show that these values are slightly in excess of the actual stresses, but nevertheless the stresses are considerably larger than those used for actual working conditions.

On the first applications of the load the beam cracked and showed considerable deflection. After the load was repeatedly applied for several days it was found that the cracks had enlarged to a maximum of 0.01 inch and the deflection had increased from 0.20 to 0.25 inch, which was probably due to a slight slipping of the reinforcing bars. Since that time no change in the beam has been noticed and the cracks close so perfectly that they cannot be detected.

It is planned to test beams of 1 : $\frac{3}{4}$: 1 $\frac{1}{2}$ concrete, using fine aggregate, and later to extend the investigation to cover leaner mixtures. Thus far only plain round bars have been used, but in the program now proposed deformed bars will be used to ascertain their advantage in increasing the number of and distributing the cracks. The reduction in size of the cracks would be of great practical advantage for the end in view, even though the number were considerably increased.

Concrete Bulkheads for Ships.

The question of reinforced concrete bulkheads for merchant ships was brought to the attention of the Bureau when the Bureau of Construction and Repair of the Navy Department asked that certain designs submitted for bulkheads of this type be investigated and some design recommended for temporary bulkheads for seagoing vessels.

A design was worked out for the working conditions as submitted by the Navy Department. This design called for a corrugated type of construction, found necessary because of the requirement of making the structure light as well as strong.

The original design was modified by a second design in which triangular fillets were replaced by parabolic sections, thus reducing the weight slightly. The later design was approved and a full-sized specimen 17 feet high and 5 feet wide was made. In order to test this specimen under conditions approximating those of bulkheads subjected to water pressure a large reinforced concrete testing frame was built, into which the bulkhead specimen would fit. The frame and bulkhead were to be bolted together top and bottom and a water seal effected by bolting on a flexible rubber felt. That the test load might be applied in excess of working loads a reinforced concrete cap 9 inches thick was made to seal the top of the frame.

The construction of the bulkhead specimen and testing frame has been completed, and the test will be made as soon as the devices for measuring stresses and deformations are installed.

Concrete Oil-Storage Tanks.

The high cost and necessity for conservation of steel were the fundamental reasons for making a study of concrete to determine its suitability for oil storage.

At the request of the Navy Department, which was contemplating the construction of concrete tanks for fuel oil storage, a study was made of numerous concrete tanks in which mineral oils were stored. To supplement the information obtained from the field survey it was decided to conduct a series of tests on small concrete tanks using a number of mineral oils from the lightest to the heaviest, also some vegetable and some animal oils. With the coming of the reinforced concrete ship has also come an increased need for knowledge of the action of oils on concrete and its resistance to penetration.

The series of tests originally started consisted of 18 1:2:4 concrete tanks of 10 gallons capacity, which were filled with 11 varieties of mineral oils, 5 of vegetable oils, and 2 of animal oils. Because of the probability that oils will be part of the cargo of concrete ships a new series of tests was started using tanks of concrete similar to that employed in the ship construction; i. e., 1 part cement to 2 or 3 parts of aggregate below one-half inch in size. Some of these tanks of the richer concrete will be tested under a head of about 35 feet and various coatings are to be used to determine their effect in minimizing the penetration of the lighter oils.

Experience with ordinary concrete tanks shows that for the heavier oils there is but a slight loss, but with the lighter oils it is proved that some oil-proof coating is essential to insure against losses that are considerably in excess of those of steel tank storage, which is considered as the best storage.

No injurious effects have been noticed with the exception of one tank in which coconut oil was stored. In this tank a slight disintegration of the walls was noted at the end of one month. The penetration of this particular oil is slight, but wherever it is allowed to come in contact with concrete it will without doubt cause decomposition of the cementing material.

It is hoped that from this investigation results of economic value will be obtained, not only for the departments immediately concerned, but to the oil industry at large.

Automatic Freezing and Thawing Apparatus.

An apparatus has been constructed for the purpose of making a large number of alternate freezings and thawings on samples of stone, brick, concrete, etc., to determine the effect of frost action on such materials. The apparatus automatically shifts the specimens from a cold chamber to a hot chamber at the intervals required for freezing and thawing. Time has not been available to determine completely the most effective operation of the apparatus, but preliminary experiments indicate that the relative durability of different materials, in so far as durability is related to frost action, can be determined in the laboratory in a short period of time.

Investigation of Building Stones of the United States.

During the year tests have been made upon practically all of the important commercial sandstones of the United States. A report of tests on 50 American marbles has been completed and submitted for publication. An investigation is also being carried out to establish a basis for grading the Indiana limestones. Seventy-two samples of this material have been collected from various quarries of the State, and physical tests on many of these samples have been completed.

Miscellaneous Investigations.

A number of limited investigations apart from those specifically mentioned in the foregoing paragraphs have been or are being conducted:

1. A series of tests is being made in connection with the concrete ship work to determine the quality and properties of "gunit," that is, concrete placed with the cement gun, in comparison with concrete fabricated in the usual manner. The tests consist mainly of compressive strength determinations upon gunite built up in successive operations, the study of different methods of operating the machine, and the value of different mixtures.

2. The Bureau was requested to determine the value of a proprietary material recommended as a plastic lining for the hulls of wooden ships. The basis of the material was a magnesian oxychloride cement, and, as anticipated, complete and early failure occurred upon exposure to salt water. The manufacturer of this compound also represented that it was of special value as a roofing and flashing material, whereupon he was requested to prepare a small model for test. This model was exposed to the weather on the roof of one of the Bureau laboratories, and showed complete failure within a few months.

3. A method of treating plaster of Paris, which was claimed to give quick strength and hardness to casts made therefrom, was found to have little or no value of itself. However, when the treated material was mixed and allowed to set under heavy pressure in a testing machine a product of much greater density and hardness was obtained. Under the conditions of the latter test the value of the treatment could not be definitely established.

4. A proprietary material which analysis showed to be essentially a mixture of one part asbestos and three parts Portland cement was submitted as a suitable compound for the production of a light strong concrete. Tests demonstrated that the mixtures recommended by the manufacturers yielded a concrete weighing considerably less, but of much lower strength than normal concrete.

5. Incident to the work for the Concrete Ship Department of the United States Shipping Board, Emergency Fleet Corporation, 14 concrete mixers were tested to determine their effectiveness in mixing cement mortars. The performance of all of these mixers under the prescribed conditions of the test was satisfactory, judging from the compressive strength of the test specimens prepared from each mix.

6. Some further data have been obtained on the value of the addition of hydrated lime to concrete mixtures. Tests were made on density, compressive strength, and rate of drying of concrete containing additions of hydrated lime up to 20 per cent by weight of the cement. Density was found to decrease slightly with the increase of lime content, whereas very little effect upon compressive strength and rate of drying was noted.

7. In connection with special work for the United States Shipping Board, an investigation was made of the effect of vibrating the forms for varying periods of time on the strength of concrete poured and allowed to set under these conditions. The interesting conclusion was reached that vigorous and continuous vibration for periods up

to three hours did not injure the concrete, and that only slight reduction in strength resulted from intermittent vibration.

8. Some studies have been made of blended cements in which diatomaceous earths from two sources have been ground together with Portland cement in various proportions. The results obtained in concretes at early periods indicated that the blended cements were inferior to normal Portland, but at 6 months a slight reversal was noted. In view of this unexpected development, a more comprehensive investigation will be undertaken to confirm these results.

Results of 1-year tests on concrete made from a slag cement were completed. Concrete made of this cement and exposed to the weather for 1 year completely disintegrated within this period.

Miscellaneous Routine Tests.

During the year the following miscellaneous routine tests have been made:

For the Panama Canal: Granular analysis of 18 samples of sand, 4 samples of sand-blast sand, 4 samples of silica grit, 6 samples of granulated cork; absorption tests on 10 samples of vitrified clay tile conduit; impact tests to determine the toughness of 6 samples of opaque glass, blood-staining tests on 18 samples of clay tiles for use in hospital floors.

For the Bureau of Yards and Docks: Physical tests including granular analysis, specific gravity, weight per cubic foot, and compressive strength in cement mortar or concrete of 10 samples of sand, 6 samples of gravel, 4 samples of crushed limestone. A sample of ground red iron ore was tested in cement mortar to determine its coloring effect. For this Bureau also a number of trips were taken to Norfolk, Va., to inspect concrete work and materials in connection with the construction of the dry dock at that point; tests were made on 6 samples of sand, 2 samples of gravel, and 1 sample of limestone.

For the United States Shipping Board: Thirty-three sands and 10 gravels from the South Atlantic Coast region were tested in concrete and mortar. Three integral waterproofing materials were also tested in concrete for their effect upon compression and absorption of the latter.

For the United States Engineer Office tests of sand, gravel, and stone for use in the new Key Bridge at Washington were made.

In addition to the foregoing individual tests were made on 16 aggregates for mortar and concrete. Thirty samples of sandstone from different portions of a well known quarry were tested for transverse strength to determine the variation of the output.

The Constitution of Portland Cement.

Owing to the demands made on the Bureau by other departments of the Government for help in testing the cement purchased by them, the amount of investigative work on Portland cement was largely reduced. It was found possible to determine quantitatively (approximately) the constitution of a large number of cements made by the Bureau of a widely varying composition, as a check on determinations made previously by another petrographer. These data have been plotted in such a manner as to show the effect of the different amounts of each constituent on the compressive strength of a 1:1.5:4.5 gravel concrete. These curves show very strikingly that

the early strengths are developed by the tricalcium silicate, while at later periods the dicalcium silicate, which hydrates at a much slower rate, adds considerably to the cementitious qualities. At the same time it appears that the "fluxing materials," such as the alumina, iron, etc., should be present in a certain definite amount, above or below which the strengths are reduced at all periods. The high-silica cements in order to develop the same cementitious qualities as the low-silica ones must have less of the "fluxing materials" present.

Hydraulic Cements Other Than Portland.

Since it was found that compounds formed by burning 65 to 75 per cent alumina with 35 to 25 per cent lime in a rotary kiln, when ground, gave hydraulic cements of very high strength at early periods (these results were given last year in the annual report and will be published during the coming year in bulletin form), it was decided to conduct an investigation for the purpose of making cement of silica and lime only. Preliminary work on a small scale showed the impossibility of combining these two materials at the temperature of the rotary kiln, without the aid of some fluxing material. It was then found that boracic acid and calcium fluoride were very desirable and useful fluxes. With the aid of these a number of cements have been burned, not containing alumina, and with a lime content of approximately 70 per cent. There was no difficulty in producing them in a rotary kiln. Their commercial use would be small on account of their very slow time of setting. They are of great interest, however, in helping to elucidate the behavior of the compounds present in normal Portland cement.

Tests of Concrete Ship Sections.

The building of concrete ships has made necessary original investigations to determine the relative strengths and behaviors of ship hulls under the loading conditions imposed by their cargoes and the impact of waves. To simulate these conditions in the laboratory a number of model girders were constructed of cement with various types of steel reinforcement and different arrangements of vertical ribs and these were tested in such a manner as to best approximate the conditions met with in practice. In a number of cases the applied loads sustained were higher than those anticipated by the designers and valuable information was obtained for marine architects and engineers.

Tests of Columns.

The report covering the results of the investigation upon 18 large bridge columns has been published as Technologic Paper No. 101. The columns under consideration in this report were half-size models of different chord members of the new municipal bridge at St. Louis, the Chicago, Burlington & Quincy Railroad bridge at Metropolis, Ill., and the new railroad bridges at Memphis, Tenn. The specimens tested ranged in length from $15\frac{1}{2}$ feet to $24\frac{1}{2}$ feet and in cross-sectional area from 42 to 110 square inches. They were constructed of carbon, chrome, silicon, nickel, and Mayari steels. Some of the columns are the largest which have ever been tested. The strengths as determined from the tests ranged from 31,000 to 46,000 pounds per square inch for the carbon-steel columns and from 48,000 to 65,700 pounds per square inch for the alloy-steel columns. The largest load recorded in absolute value, 6,768,500 pounds, was borne

by one of the nickel-steel columns having an area in cross-section of 110.3 square inches and a length of 24 feet, the ends of the column being square. It was found that the strengths of 12 columns which failed as units were approximately in accord with the yield points of the component steels, the average strength of the columns in compression being nearly equal to the average of the yield points of the component steels as determined by tensile tests. The range in variation in individual cases was between 3.7 and 12.5 per cent in absolute value. Four of the columns failed locally by bending at the ends, and 2 more by localized failures in the lattice, these not developing the full estimated strength of the members. Ten columns of the series failed in smooth flat curves without irregular action of any kind, showing it is easily possible to obtain integral action of the steel in large built-up members.

An investigation has also been under way in cooperation with one of the large bridge manufacturing corporations to obtain information as to the strength and other properties of columns constructed of rolled angles and used so extensively in built-up trusses, towers, and other frameworks. To date 167 columns varying in length from 3 to 25 feet and in dimensions from $2\frac{1}{2}$ by $2\frac{1}{2}$ inches to 6 by 6 inch angles have been tested. It appears desirable after consultation with the manufacturers to make further tests before completing the investigation.

Tests of Cement and Concrete.

The routine testing of cement and concrete for the public and the different departments of the Government has been greater during the past year than in any previous one in the history of this branch of the Bureau. Owing to the inability to secure experienced testers to carry on this work, it was necessary to curtail to a marked degree all investigative work in this connection. There was sampled and tested during the year 361,000 barrels of cement for Government contracts, 221,000 barrels were shipped, 27,580 barrels were rejected for not having fulfilled the requirements of the specifications, and 30,000 barrels were withdrawn by the manufacturers, after sampling but before testing, as the latter had found the cement unsatisfactory. The amount of rejected and withdrawn material may seem to be excessive, but considering the present condition of the labor situation, necessitating the use of many new or partially experienced men, this is not too large. It does illustrate the need, however, of constant testing to insure the securing of satisfactory material.

MISCELLANEOUS MATERIALS.

(Investigation and testing of miscellaneous materials, including lubricants, leather, rubber, textiles, and paper; the design of apparatus and machines for testing such materials; the development of methods of test; and the preparation of specifications for the purchase of miscellaneous materials by the Government.)

LUBRICANTS.

Lubrication of Airplane Motors.

Considerable work has been done on the problem of airplane-motor lubrication. This Bureau cooperated in the laboratory testing of oils in connection with a series of motor tests carried out by the Lubrication Section of the Signal Corps at the Washington Navy Yard. Motor tests are now being made at the Bureau for the pur-

pose of comparing the value as lubricants of both asphalt base and paraffin base oils, as well as colloidal graphite. It is hoped by a comparison of laboratory tests on oils with engine performance to discover the physical and chemical properties indicative of the most satisfactory lubricant, and to prepare specifications which shall insure the purchase by the Government of the best lubricants which can be manufactured.

Specifications for Lubricating Oil Purchased by Government Departments.

The work of writing oil specifications for the General Supply Committee has been continued, and all oils are now purchased by specification. The method of buying on a basis of guaranteed lubrication was found unsatisfactory and has been completely abandoned. The question of viscosity of gasoline and its influence on engine performance is under investigation.

Investigation and Tests of Lubricating Oils.

The standardization of the Saybolt universal viscosimeter, mentioned on page 142 of report for 1917, has been completed, and the results have been published in Technologic Paper No. 112 and also in a paper presented before the American Society for Testing Materials in June. Technologic Paper No. 86 on the test for resistance of an oil to emulsification has been reprinted to meet the continued demand.

Testing of Lubricants.

During the year 555 samples of lubricants have been tested, and 170 letters have been written in answer to request for information concerning the testing of lubricants.

LEATHER.

Investigation of Leather Goods.

The annual report for the fiscal year ending June 30, 1917, contained an announcement of the inauguration of leather investigations with the cooperation of the National Association of Tanners, together with a discussion of some of the preliminary work which had been undertaken at that time. Since then the work has been developed and expanded. With an increase in personnel, funds, and equipment, it has been possible to expedite several problems, both physical and chemical, closely related to Army problems. However, owing to the lack of laboratory space it has not been possible to keep pace with the program which the Bureau has outlined. As soon as the new Industrial Research laboratory is ready for occupancy such difficulties will be obviated and the expansion can proceed satisfactorily.

The chief problem which the Bureau has undertaken in connection with Army shoes is the investigation of the wearing quality of sole leather as related to the chemical treatment in the tanning and finishing processes.

There are six particular experiments in connection with oak-tanned leather which are now under way to throw light upon this problem. These are:

(1) A comparison of the wearing quality of belting tannage with sole tannage.

(2) A study of the effect on wearing quality of loading with glucose as compared with the process of finishing with no glucose.

(3) A determination of the effect of oil on the wearing quality of sole leather.

(4) A comparison of the wearing quality of leather containing a high percentage of water-soluble materials with leather containing a low percentage of water-soluble materials.

(5) A comparison of the wearing qualities of leather of different vegetable tannage, viz, oak and hemlock.

(6) A comparison of the wearing qualities of vegetable-tanned leather with mineral-tanned leather.

The hides used in the above experiments have been carefully selected by representatives of the Bureau and data regarding the history of the hides have been obtained. The experiments are being conducted in three ways:

(1) By service tests conducted with soldiers at Camp Meade, Md.

(2) By abrasion tests upon the bureau's wearing machine.

(3) By complete chemical analyses.

The exact location of the test soles and specimens on the hide is known, so that a comparison of the results should give valuable information.

The Bureau has carried out a rather complete investigation of the wearing quality at different points in the bend and has obtained some very interesting results.

There have also been in progress wearing tests both with the leather-testing machine and by means of service tests upon postmen and soldiers in camp to determine the wearing quality of various brands of fiber composition soles as compared among themselves and as compared with sole leather. Some interesting and instructive data have been obtained and have been reported to the War and Navy Departments.

These experiments are to be greatly enlarged in the near future, and tests are to be made to determine the adaptability of fiber half soles to camp repair work.

Wearing tests have been conducted on the leather-testing machine to compare the wearing quality of lightly and heavily rolled sole leather. In addition to observing the relative wearing quality of lightly and heavily rolled leather, the rate at which the wear progressed was also studied.

In cooperation with the Ordnance Department, this Bureau conducted tests on sides of russet harness leather and russet strap leather. The sides were blocked off, numbered, and photographed and subsequently subdivided into test specimens which were tested for tensile strength, buckle-shearing resistance, and tearing resistance, with the view of ascertaining whether any relation exists among these three physical properties.

A detailed report of the results of these tests has been transmitted to the Ordnance Department.

Specifications for safety belts for aviators have been furnished the Chief Signal Officer of the Army.

At the request of the office of the Quartermaster General rubber cements used in cementing leather to leather, leather to rubber, and rubber to rubber were tested to ascertain the comparative values of different brands.

The Bureau is studying the question of water absorption of sole leather, the use of waterproofing materials, the heat conductivity of leather as compared with leather substitutes, viz, fiber composition soles, and other problems of a kindred nature.

Service tests have been made for the War Department to determine the relative water resisting properties of vegetable-tanned as compared with chrome-retanned upper leather. The regulation Army shoes used for this test were made with vegetable-tanned leather on one shoe and retanned leather on the other.

The Bureau has cooperated with the Bureau of Fisheries in developing methods of tanning shark and other fish skins. As a result of this work tanned skins have been produced of a quality that renders them well adapted as a substitute for certain classes of leather. Numerous tests of these tanned skins have been made to determine their physical properties.

Routine Tests of Leather.

A part of the time of the personnel is consumed in conducting routine tests for various Government departments, particularly the office of the Quartermaster General and the Ordnance Department of the Army and the General Supply Committee and the Panama Canal. These tests consist chiefly in chemical analyses, the determination of tensile strength, ultimate elongation, tearing resistance and other physical properties of leather belting, harness leather, strap leather, lace leather, and leather fan belts. During the year a great many samples of leather have been so tested and reported. There have also been made tests of various materials more or less closely connected with leather goods, e. g., shoestrings, rubber heels with steel heel plates, fiber middle soles, etc.

RUBBER.

Investigation and Testing of Rubber.

The physical work of the Bureau on rubber consists of:

- (1) The determination of its physical properties and the investigation of methods of testing.
- (2) The investigation of rubber products of various kinds at the request of Government offices to determine their adaptability under special service conditions.
- (3) The development of standard specifications for the purchase of rubber goods by various Government offices. At this time the Bureau is acting in advisory capacity in the development of standard specifications for rubber and leather goods for the War Department.
- (4) The testing of samples submitted by Government offices to determine if the material meets the requirements of the specifications upon which it is purchased.

Cooperation with Technical Societies and Testing Laboratories Representing Manufacturers and Consumers.

The Bureau has continued its cooperation with technical societies and testing laboratories in developing specifications for and methods of testing rubber goods. This work serves the double purpose of keeping the Bureau in touch with progressive manufacturing practice and of rendering the Bureau's laboratory facilities available to the industries.

Experimental Rubber Plant.

The Bureau's experimental plant, which includes machinery and apparatus for compounding and vulcanizing rubber, has been utilized during the past year, but the work has been handicapped to some extent by the frequent demands of Government office for investigations and tests of manufactured rubber products of various kinds.

During the past year a number of compounds have been mixed for the use of the chemical section for checking their methods of analysis. Tests of some of these compounds have resulted in the development of methods for the analysis of lampblack, glue, and other nitrogenous matter. These results appear in the revised copy of methods of analysis formulated by the chemical section. In addition about 40 rubber compounds in which different organic accelerators were used, were mixed, vulcanized, and tested to determine their physical properties. It is proposed to make compounds containing materials in which sulphur appears in various forms, for the purpose of determining what effect they have on sulphur determinations.

In the manufacture of rubber goods organic accelerators have come into general use. As yet very little has been published concerning the effect of these accelerators on the quality and life of rubber articles. This Bureau plans during the coming year to carry through a complete investigation on organic accelerators. The compounds will be mixed here at the Bureau, all precautions for obtaining accurate results being carefully taken. Not only will the ordinary tests of these various compounds be carried out, but an attempt will be made to see if there is any relation between the natural aging of rubber materials and accelerated aging, such as the effect of dry heat, sun's rays, and ultra-violet rays. The vulcanizing press is to be equipped with mercury thermometers and means for automatic temperature control which will enable careful regulation of the actual vulcanizing temperatures.

The curtailing by the War Trade Board of the amount of crude rubber that may be imported, coupled with the successful results being obtained with cultivated Guayule in California, has opened up another problem. The Bureau plans to investigate the possibilities of substituting Guayule for the higher grades of rubber in certain classes of goods.

Solid-Rubber Truck Tire Tests.

At the request of the Quartermaster General of the Army, the Bureau undertook the testing of a number of solid rubber truck tires, with the view of securing standard specifications for military use. These tires were not only subjected to the ordinary laboratory tests but were tested for elasticity, hardness, and resistance to abrasion. From the results of the Bureau's tests considered in connection with the observed behavior of similar tires on the Mexican border, specifications were drawn up for the purchase of solid truck tires. These specifications with slight modifications have also been used for the purchase of gun carriage tires.

In connection with the investigation of solid rubber tires the Bureau has made for, and in cooperation with, the Inspection Division of the Ordnance Department of the Army a series of tests to study the adhesion between the tread stock and hard rubber base in various makes of tires. A great difference in this adhesion was found in the case of different tires which is in accord with the re-

sults of experience under service conditions. A study was also made of the different degrees of elasticity in the tread stock of different makes of tires. Specifications for solid tires now include requirements for adhesion and elasticity which are determined by tests at the factory.

In order to maintain a satisfactory control over the quality of rubber compounds used, inspectors for the Quartermaster and Ordnance Departments submit regularly to the Bureau samples of rubber for test and analysis as a check on the results obtained at the factories.

Pneumatic Tires and Tubes for Automobiles, Motorcycles, and Bicycles.

The Bureau has undertaken the investigation of pneumatic tires and inner tubes for the office of the Quartermaster General, with the object of drawing up standard specifications for tires and tubes for Army use. Between 30 and 40 of the standard nonskid makes of both cord and fabric tires, 35 by 5 inches, and 20 inner tubes were bought in the open market and submitted for investigation. It was apparent that our regular force was not sufficient to carry out this investigation within the time required and 5 enlisted men were detailed to assist in cutting and preparing samples for test.

The tires and tubes have been tested in various ways. The rubber from the tubes and the treads and side walls of the carcass have been analyzed and subjected to physical tests while in their normal condition and after having been given various accelerated heating tests. A number of adhesion tests were made with samples taken from various parts of the carcass between the plies of fabric, fabric and side wall, fabric and cushion, and breaker and tread. The effect of heat on the frictioning compound between the plies of fabric was also determined. From these results specifications have been drawn up for cord and fabric tires and inner tubes for Army use. The investigation is not entirely complete. A number of the tests that had been planned are still to be conducted. It is proposed to carry out actual natural aging tests on such material from tubes and casings as may be left to check against the heating tests which will give valuable information for future use.

A number of standard makes of nonskid motorcycle tires and inner tubes were submitted by the Engineering Bureau, Motor Transport Section of the Quartermaster Department, for test, with the object of drawing up specifications for motorcycle tires and tubes for Army use. These tires and tubes were measured and examined carefully, all necessary and important measurements were taken, and the tires and tubes were subjected to various accelerated aging and physical tests as well as chemical analyses. The rubber from the tubes, treads, and side walls of the casings were subjected to tests for elasticity, strength, and elongation after 0, 4, 9, and 14 days in dry heat at 160° F. and for the same periods of time in dry heat at 228° F. From the results obtained to date specifications have been drawn up for the purchase of motorcycle tires for both the Quartermaster and Ordnance Departments of the Army. Various adhesion and fabric tests were also made. The tests are not entirely completed but they are expected to be finished within the next month.

A number of single-tube and double-tube single and double clincher bicycle tires and bicycle inner tubes were tested for the Engineering

Bureau, Motor Transport Section of the Quartermaster Department of the Army. The results of these tests will be used in preparing specifications for Army use.

Airplane Materials.

During the past year a number of airplane cords, high-tension cables for aviation engines and airplane shock absorbers were tested for the Aviation Section of the Signal Corps.

Gas-Mask Materials.

The great demand for gas masks and gas-mask equipment, caused by the entrance of the United States into the present world war, has opened a new line of work for this Bureau. The Bureau has been carrying out in cooperation with the Gas Defense Service and the Bureau of Mines Experimental Station at American University various investigations on rubber materials, head strap elastics, check and flutter valves, and eyepiece materials. The Bureau has also acted in an advisory capacity in drawing up specifications for and in designating methods of testing the various materials used in connection with gas masks. Among the various materials tested for the Medical Department of the Gas Defense Service are rubber rings for lens washers, elastic webbing for head straps, rubber mouthpieces, rubber nose pads, and rubber stock for mouthpieces, check valves, and flutter valves. The following materials were tested for the Bureau of Mines: Rubber mouthpiece stock, elastic webbing for head straps, celluloid for eyepiece stock, adhesive tape and rubber flutter valves.

Tests of Medical Supplies.

During the past year the Bureau has tested a number of samples of adhesive tapes, hospital sheeting, open-center invalid ring air cushions, and hot-water bottles for the Field Medical Supply Depot of the Army. On several occasions samples submitted by manufacturers have been sent to the Bureau to have them rated in the order of best quality as determined by the results of tests.

On one occasion bid samples representing a proposed purchase of 70,000 hot-water bottles and invalid air cushions were submitted with a request for an immediate report as to the relative suitability of the various makes for purchase, based on considerations of quality and cost. The desired information was furnished the following day. The results of our examination and preliminary tests were in accord with and verified by a detailed report, which was furnished later as a result of more extensive tests, including accelerated aging tests in hot air and hot water.

Tests of Hose and Packing for the General Engineer Depot of the Army.

At the request of the General Engineer Depot of the Army the Bureau has conducted numerous special tests of water, suction, and fire hose, representing various commercial brands as well as hose manufactured to definite specifications which were prepared with the Bureau's cooperation. Special tests have also been made of rubber packings for aeronautical instruments to determine the behavior of different compounds under freezing conditions at high altitudes.

Tests of Fire Hose for Government Departments.

For several years past the Bureau has tested all rubber-lined fire hose purchased by the District of Columbia Fire Department. Contracts for this hose are made under competitive bids according to specifications that have been revised by the Bureau of Standards. This method of procedure has resulted in a material saving in cost to the fire department and at the same time has served to maintain a high standard quality and efficiency of hose.

During the past year samples representing 10,000 feet of 2½-inch hose and 3,000 feet of 3-inch hose have been tested for the local fire department under specifications which require that all delivered be tested as a check on the original bid sample.

Tests have also been made on a number of samples of fire hose submitted by the Panama Canal, the Post Office Department at Washington, D. C., and the General Engineer Depot of the Army.

Rubber Insulated Wire.

The Bureau has carried out further natural aging tests on rubber insulation of wire in cooperation with a number of other testing laboratories identified with the American Society for Testing Materials. The object of these tests is to determine the relation between the natural aging under atmospheric conditions as compared with the effect of dry heat at 160° F. The heating tests were carried out several years ago, and this year completes the aging tests. The results of this investigation will be carefully studied and compared with similar investigations that have been in progress at the Bureau for several years.

The Bureau has also tested a number of samples of rubber-covered wire for different branches of the War Department. Numerous samples of plain rubber-covered wire, waterproof insulated wire, high-tension cables, submarine mine cables, underground cables and telephone cables, have been tested for the Chief Signal Officer of the War Department, the Coast Artillery Corps, the Torpedo Depot at Fort Totten, N. Y., the Motor Transport Service of the Quartermaster Department, the Equipment Division Laboratory, and the Panama Canal.

Tests of Miscellaneous Materials.

There were tested during the past year a total of 1,697 samples of miscellaneous materials, an increase of 80 per cent over the previous year. A large proportion of these tests were for the various branches of the War Department and in many cases were of an urgent military nature. Many of the tests were of a semi-investigative character, requiring special equipment and preparation.

The following materials were submitted by the Equipment Division of the Ordnance Department for test: Cotton woven straps, rope halter ties, lanyards, rope lariats, buckles, rings, hooks, thimbles, metal snaps, etc.

The Engineering Bureau of the Ordnance Department submitted rubber fuse caps, rope lariats, hooks, links, thimbles, a number of samples of dredging sleeves, etc.

A number of specimens of frictioned cloth, O. D. uniform twill and rubberized and combined sateen fabric, were tested for the Inspection Division of the Ordnance Department.

Various samples of rubber-covered wire, submarine cables, underground cables, rubber tubing for water, oil, and gasoline were tested for the Signal Corps of the Army.

A number of samples of leather preservatives, leather waterproofing compounds, rubber cements for shoes, rubber, etc., motorcycle footpads, motorcycle handle bar grips and pedal grips, asphalt-saturated cloth for waterproofing, steering wheels for motor trucks, etc., were tested for the Quartermaster Department of the Army.

Samples of adhesive tape were tested for the Research Division of the Chemical Warfare Service. The Bureau acted in an advisory capacity in drawing up methods of testing and specifications for adhesive tapes.

On several occasions samples of soft-laid flax shot line were tested for the United States Coast Guard. These lines were tested with special grips which were designed at the Bureau especially for the purpose.

The following items are representative of the routine tests made during the past year: Five hundred and fifty-five samples of lubricants; 485 samples of leather; 127 samples of rubber hose, such as air, air-brake oil, water, fire, suction, steam, etc.; 70 samples of packing consisting of asbestos, rubber, etc.; 64 samples of pneumatic tires, consisting of automobile, bicycle, and motorcycle; 65 samples of solid truck and gun carriage tires; 149 samples of rubber-covered wire and cables; 215 samples of gas-mask materials, consisting of mouth-pieces, flutter valves, check valves, eyepiece stocks, lens washers, etc., and smaller quantities of numerous other materials.

The greater part of the routine tests were made at the request of Government departments in connection with the award of contracts and to determine if the materials delivered on contracts were in accordance with specifications.

TEXTILES.

Blanket Investigations.

About a year ago, the Quartermaster General of the Army, realizing that there existed a great need for more effective blankets with regard to warmth, durability, and lightness, requested this Bureau to investigate the possibility of replacing the present Army blanket with one better adapted to the purpose. It was suggested that the relative advantages of various kinds of raw fiber and of various manufacturing procedures be given attention.

In accordance with this request, the Bureau has undertaken to classify some of the commercial types of blankets according to their respective abilities to resist the transmission of heat. The various blanket manufacturers showed much interest in this work and readily agreed to furnish us, free of charge, a considerable number of blanket samples. These were tested for heat conductivity on an apparatus specially designed for the purpose. The several results were compared with those obtained with the Army blanket. It was found that the fiber composition did not materially affect the result, the cotton blankets being as satisfactory as the wool within the limits of the test. The factors vitally affecting the results were found to be weight and method of manufacture.

Consideration was next given to studying methods of manufacture. In this work again the manufacturers showed a willingness to cooperate, but it was found that they could not be of material assistance because their plants are designed for routine production and can not be readily adapted to the construction of special fabrics for experimental purposes. This difficulty, it was seen, would apply with equal force to similar work on clothing materials of all kinds, and therefore it was decided to install a small woolen manufacturing plant at this Bureau, where experimental fabrics could be made under rigidly controlled conditions and test results could consequently be interpreted with reference to the manufacturing procedure used. This plant is now being installed and should be in running order very soon.

It has not been possible as yet to investigate the durability of these materials owing to lack of the necessary materials and equipment. This phase of the problem is of great importance from the viewpoint of conserving the Nation's wool supply.

Uniform Fabrics.

An effort is being made to anticipate the demand for work, similar to that outlined under "Blanket investigations," as applied to fabrics for uniforms. The tremendous demands for woolen materials for Army purposes is sure to cause a critical shortage in the wool supply. This will have to be met either by increased efficiency of use, by the use of substitutes or by importation from foreign countries. The last alternative would involve the use of shipping much needed elsewhere. It is the purpose of the Bureau during the coming year to study the use of substitutes and the adaptation of manufacturing methods to specific service requirements in order to alleviate, in so far as possible, the threatened shortage. This work will be pursued with the utmost vigor, provided the necessary equipment can be obtained.

The textile work of the Bureau, particularly as applied to woolen fabrics, has been seriously handicapped for lack of funds. In view of the grave importance of properly clothing the men of our Army and of providing them with blankets and other woolen equipment, it is very necessary that the personnel and materials required be provided. The work has received the universal indorsement of Army officials, manufacturers, and consumers, and it is believed that it constitutes one of the most promising fields for Bureau of endeavor.

The saving effected by an adequate appropriation would be many times the expense involved, considering only the present year. The work done would be of a permanent nature and further saving in subsequent years, due to work done this year, would therefore be cumulative.

Airplane Fabrics.

At the beginning of the present war, it was evident that the flax crops would not be sufficient to supply the demands for airplane wing coverings. Inasmuch as this country grows but very little fiber flax and has no machinery for spinning the proper yarns for airplane fabrics, it became necessary to substitute our most abundant fiber.

Accordingly the National Advisory Committee of Aeronautics requested that the Bureau investigate the possibility of finding a suitable substitute for the linen. The many previous experiments on cotton and silk had supposedly demonstrated that the substitution was impossible. However, the Bureau under these unfavorable conditions enlisted the cooperation of the cotton manufacturers of this country and began a series of experiments. The willingness of the manufacturers to assist was extremely gratifying, and throughout the entire time they have always been ready to provide samples of varying structure in the shortest possible time.

The properties of the satisfactory linen fabrics were studied and the desirable properties of airplane wing coverings were investigated. From these studies the characteristics of the theoretically perfect fabric were determined. It then became necessary to duplicate these properties in a practically possible fabric. As a result, a cotton airplane fabric has been developed which is considered superior to linen, and which has relieved a serious situation in our airplane program.

The linen situation had developed to a point where it was necessary for the countries associated with the United States in the war to look for other fabrics, and England has already adopted our cotton fabric and found it satisfactory.

Many experiments were performed on silk, and other fibers to be had in fairly large quantities, but in most cases the results were not encouraging.

The work along these lines is being carried on with the view to improving present ones, to develop satisfactory fabrics from other fibers and to provide satisfactory fabrics for new types of planes. The enthusiasm of the manufacturers has been very gratifying. Many manufacturers are offering practical cooperation on the various problems involved.

Attaching of Fabrics to Planes.

The existing methods of attaching and tying fabrics to wing structures has caused in the past a considerable amount of trouble. The Bureau has investigated methods of sewing seams, tying, etc., and the materials used in these operations, and has succeeded in making the conditions much more safe and satisfactory.

Inspection of Airplane Fabrics.

At the request of the Signal Corps, detailed methods of inspecting the airplane and balloon fabrics were outlined and put into effect. The methods have been satisfactory.

Balloon Fabrics.

The Bureau, at the request of the balloon sections of the Army and Navy, has experimented extensively on cloths to be used in the manufacture of balloon fabrics. The foreign balloon fabrics were made almost entirely of cotton and it was a comparatively easy matter for our manufacturers to duplicate these fabrics.

These fabrics are not all that could be desired and the cooperation of the cotton manufacturers has enabled us to develop fabrics which are much more satisfactory. These experiments are still in progress

and it is hoped that they may be completed in a comparatively short time. These fabrics promise to be much more easily produced and it is anticipated that they will satisfy the conditions of stresses in a balloon much more satisfactorily than the present ones.

Balloon Seams.

Extensive experiments on the design of balloon seams have been carried out to determine a seam to most effectively resist the system of stresses involved. It was found that in many cases a simpler seam than those used in foreign practice could be designed.

Parachute Fabrics.

The problem of obtaining satisfactory man and flare carrying parachutes was not particularly difficult, as the foreign silk fabrics could be quite easily adapted to our manufacturing facilities. A very material assistance was given to the military departments in selecting the best fabrics and in measuring the relative efficiency of our own products.

Physics of Airplane Fabrics.

Our early experiments on airplane fabrics lead to the conclusion that many of the factors influencing the behavior of fabrics were not satisfactorily explained, for many of the experiments were more or less impractical.

At the present time, the theory underlying the performance of airplane and balloon fabrics is little known, and the more recent developments in airplane design have caused us to turn our attention to this field. The work is progressing rapidly, and it is anticipated that more efficient fabrics will be evolved and that the airplane designer may predict the performance of any fabric with a reasonable degree of certainty.

Packing of Textiles.

At the request of the Quartermaster General a series of experiments were conducted to determine the smallest size of bale in which a given quantity of the various materials could be packed without injury to the fabrics.

The War Industries Board requested that an investigation be instituted to determine the most economical method of packing textiles for the retail trade, with particular reference to the effect of the method on the properties of the material. These experiments were never completed, due to the lack of proper facilities, but much valuable information was collected. The importance of such an investigation is readily realized when it is considered that in many cases large amounts of shipping space may be saved without seriously injuring the materials.

Miscellaneous Military Materials.

A very limited amount of work has been done on such military fabrics, as dugout blankets, stockinettes, gasmask fabric, stockings, tentage, cordage, and the like.

Specifications for many ordinary materials have been written and placed in the hands of proper authorities.

Test Methods.

The growing prominence of the necessity of testing textile materials, together with the introduction of many new fabrics, has made it necessary to develop the art of testing to a much higher degree than heretofore.

Several important methods of testing have been devised, particularly in regard to aeronautical fabrics, in order that the probable performance of the materials may be anticipated.

The development of new test methods has been accompanied by the necessity of developing new testing machines, all of which have proven to be of material assistance in the selection of proper fabrics for the right one.

Microscopy.

The importance of a microscopical examination of textile materials has long been established, but it was not until this year that we were able to install a satisfactory microscopy laboratory. This laboratory has already been of tremendous value, particularly in the examination of German and other foreign fabrics and in connection with the study of rubberized fabrics.

Industrial Laboratory.

The pure research work of the section has been in the past severely handicapped because of the inability of the research man to be supplied with samples of known value. To overcome this difficulty there is now being installed a complete felt, woolen, and cotton mill for the preparation of samples to be investigated as to their properties.

The value of such a laboratory is realized when it is considered that the textile industry has never scientifically investigated its products. It is anticipated that the future will bring forth keen competition in textiles, and it would appear essential that the American manufacturer should know more exactly the factors governing the quality of his output in order that he may more satisfactorily compete with other nations.

The importance of such information is emphasized when it is considered that the large textile nations are now instituting elaborate plans for the thorough investigation of textiles, and that in many cases the results of the investigations will be more or less constrained to distribution in their own country.

The National Council of Cotton Manufacturers of this country, which represents practically every cotton mill in the country, has pledged its support to the furtherance of our work on cottons and has offered every cooperation which we may desire.

The importance of industrial research on textiles is so very great that it is urged that every effort be made to facilitate concentrated investigations.

PAPER.

Investigation and Testing of Paper.

The general work of the paper section is divided into two parts, namely, routine testing and research investigations. Under routine

testing, is included the testing of samples of paper and paper products, for the various government establishments. In most cases this work includes the testing of samples to determine compliance with a standard specification or an accepted sample. Under routine testing is also included the preparation of standard specifications of paper for particular purposes. In some cases the development of a standard specification may even require the development of special tests designed to meet some special factor, by which the quality of a material may be definitely recorded. The paper section has assisted many of the governmental establishments in the preparation of standard specifications and is continually urging upon all that paper can not be intelligently purchased upon any other basis.

In the part designated research investigations is included all work other than that of a purely routine nature. Under this heading are taken up the problems of the industry as applied directly to manufacturing technology. Previous to the beginning of the war, the paper section had under way a number of problems of importance to the industry. The demand of the Government for paper and paper products has grown so materially during the past year that almost all of the research problems pertaining to commercial technical interests have had to be discontinued. The work on buttermilk casein adhesives, filter paper, paper-making clays, sizing methods, and other problems have not been abandoned, but have of necessity given way to problems having a more direct war bearing.

Utilization of Wall and Plaster Board.

The use of wall board and plaster board as a building material for the construction of military cantonments, Government warehouses, office buildings, and similar Government needs has developed to a great extent in the past year. Wall board is a general term covering those types of building material which are used as a substitute for wood lath and plaster in partitions and for sheathing on the inside walls of buildings. The construction of the vast number of Government buildings demanded in the prosecution of the war required the use of a material that could be quickly erected, have a low cost, as well as adequate supply. This necessity was met by the use of over 100,000,000 square feet of wall board.

Wall boards are made of paper, built up of one or more layers or plies that are cemented together with a binding agent such as silicate of soda (water glass) or other adhesive. Plaster board is made of 3-ply construction. The inner ply is made of hydrated plaster of Paris or gypsum, while the two outer plies are made of a special paper. The finished boards are in thickness of three-sixteenths, one-fourth, and three-eighths of an inch.

Plaster board has fire-retarding properties superior to ordinary wood lath and plaster and far superior to the all-paper wall board. The strength of this material together with its fire-retarding properties and other qualities make it an excellent building material and one that will undoubtedly come into more general use as its properties and usefulness become more generally known.

The term wall board applies only to that type of wall covering that is made entirely of old paper stock, ground wood pulp, or other paper making fibers.

Through the War Department, the Bureau was requested to assist in the preparations of specifications and methods of testing to determine those qualities required. Special methods for testing this wall board had to be devised, in order to duplicate as nearly as possible, service conditions. Samples of all the commercial grades were secured and tested and their relative suitability determined. As the War Department has already used great quantities of this material and is contemplating using much more of it in the near future, the need of complete data of the service of this type of building materials can not be overestimated. The actual service rendered by this wall board has been investigated at various cantonments and in buildings lined with wall board and plaster board erected over a year ago. The result of this general investigation has been to improve greatly the quality of the wall and plaster boards used by the Government. Much of these good results have been made possible by the hearty cooperation of several of the large manufacturers.

Development of Special Papers.

As a result of a demand for special papers by several branches of the military departments, the paper section has carried on experimental work to develop papers having special characteristics. An extra strong paper has been produced, having tensile and bursting strength greatly in excess of any commercial papers so far encountered. This paper can be produced commercially and has possibilities not only for certain military uses but also for warp threads in making strong paper textiles. A detailed study has been made of the control of the process of manufacture, with the result that duplicate lots are readily produced.

Special studies have been made of waterproof lining papers used in wrapping goods for overseas shipments of military supplies. This work has demonstrated the fact that it is necessary to use a craped or corrugated paper in wrapping the bales. This crape or corrugated feature adds the necessary stretch to the paper wrapping, thereby preventing the breaking open of the bale of goods when handled roughly.

Paper-Testing Devices.

In connection with the development of papers of high tensile and bursting strength, it was found necessary to develop a tearing test that would enable this quality to be expressed in numerical values. The need of such a test is important and plans have been made to construct an instrument that will measure this quality.

Means by which the sizing quality of paper could definitely be expressed have always been in demand of the paper industry. The chemical analysis of a paper does not give results that can be used to show relative sizing effect. With this need in view, a modified electrical conductivity method of determining the sizing quality of a paper has been used successfully, developed, and indications point to the fact that by this method sizing quality may be recorded in numerical terms.

Filter Paper for Explosives Testing.

Through the efforts of this Bureau, a sufficient supply of a special filter paper was obtained for the Navy Department. This paper is of the highest importance as it is required to determine the stability of high explosives purchased by all the military branches.

Information Furnished on Paper.

Special assistance has been given in by this Bureau to the Federal Trade Commission in connection with the newsprint investigation; to the Council of National Defense in regard to importation and use of china clay in the paper industries; to the Shipping Board relative to the use of clay, casein and rags in the paper industry; to the Pulp and Paper Section, War Industries Board, in supplying technical information (the Paper Section being represented on the Pulp and Paper Section) relative to the pulp and paper industry; to the Bureau of Mines for cooperative work in connection with the development of a paper as a smoke-filtering medium; and to the Joint Committee on Printing, and the several Government departments, as well as the General Supply Committee, in connection with the preparation of specifications for paper and allied materials.

It is impossible to enumerate the whole range of inquiries that are constantly being received, but the following will outline in brief the more important ones:

Paper containers.—Specifications of paper containers to be used for shipment of axle grease and similar substances overseas. A compact paper container was desired in connection with the conservation of tin and steel, and also to provide a small compact package of axle grease to be issued to drivers of motor cars, tractors, wagons, and gun carriages.

Absorbent paper.—During the past year an absorbent material has been produced and placed upon the market by several manufacturing companies. This material is made from bleached chemical pulp. In appearance it resembles ordinary absorbent cotton, with the principal difference in that it is made in very thin layers which are very much lighter in weight than the lightest tissue paper. This material is also very heavily craped. This wood pulp "cotton" is coming into very important use as a surgical dressing to replace absorbent cotton. It will absorb practically as great a weight of moisture as cotton and has an added advantage of absorbing very much more rapidly. The material being of a lower price than absorbent cotton and being somewhat more easily handled, will undoubtedly replace cotton for this class of work. Both the Army Medical Service and the American Red Cross are large users of this material and the paper section has also been able to interest the Public Health Service in this material.

Paper bandages.—The laboratory has recently received samples of paper bandages made from specially prepared paper. A bandage of this kind is not as resistant to moisture as a cotton cloth bandage, yet it has a number of advantages in that it is lower in price and because of the way in which it is made, it conforms more readily to wrapping around irregular surfaces. This paper bandage for surgical

dressings will undoubtedly come into more and more general use. They are not substitutes, but should be considered in the light of new material, having certain advantages over the ordinary absorbent cotton and cotton bandages.

Many inquiries have been received covering all phases of manufacturing details and the paper section has endeavored in every way possible to supply the necessary information desired. Several American manufacturers of vegetable parchment paper used for wrapping meats, fish, butter, cheese, etc., have had difficulty with both the Australian and New Zealand customs authorities in securing a correct classification for the American parchment papers. This matter was called to the attention of this Bureau and after considerable correspondence this Bureau was able to point out to the customs authorities mentioned that their regulations did not in any way restrict the American product. It was also called to their attention that their method of testing did not enable anyone unfamiliar with the subject to make a correct decision as to whether the paper was or was not a true vegetable parchment paper. The Bureau endeavors at all times to assist American manufacturers in broadening their commercial field and is in a position to take up with foreign authorities the discussion of customs regulations which might tend to discriminate against the American product, especially in questions where the regulations may not have been correctly interpreted.

Assistance to paper industry.—Many requests for standard samples and specifications used by the Government have been received and complied with. In addition to this many specifications have been prepared to meet the requirements of paper for special purposes.

The continual increase in the number of visitors is an indication of the growing interest which both the trade and the general public are taking in matters pertaining to paper and paper products. A great many of these visitors are of the type that desire general information relative to paper and paper testing and the possibilities of developing specifications for paper for particular purposes. Since the beginning of the war, however, there has been a steady increase in the number of manufacturers who have visited the laboratory. The general purposes and aims of the laboratory are explained and every effort is made to demonstrate the necessity for carefully controlled experimental work. A number of large paper companies have planned a way by which they propose to install a complete experimental equipment similar to the one here at this Bureau. Such inquiries are given every possible assistance, as it has been demonstrated that a superior and more uniform product is secured from those mills that are considering manufacturing problems from a scientific standpoint.

Summary of Tests.

The Bureau has tested for the Government Printing Office and Government departments 5,277 samples of paper. It has tested for public and private interests 420 samples of paper, making a total of 5,697 samples tested. This is an increase of 83 per cent over the preceding year and indicates the increased use of this branch of the Bureau's activities, brought on by war conditions.

8. METALLURGY.

[Thermal analysis and structure of metals, heat treatment and its effect upon the properties of metals and alloys, including the researches involved in determining the causes of metal failures, cooling and heating curves; the investigation of hardening, annealing, tempering, cementation; the determination of critical ranges; and the preparation of pure metals and alloys.]

Equipment.

In view of the fact that the Metallurgical Division has just completed removal into new and greatly enlarged quarters and is acquiring considerable new equipment, it may be of interest to mention some of these items as an indication of what we are prepared to do in metallurgical investigation and testing. The plan laid down is, to be able to make any metal or alloy, give it any desired thermal and mechanical treatments, and carry out any required test or investigation of its properties. The manufacturing scale adopted, up to quarter-ton units, appears sufficient to warrant reaching "practical" conclusions.

The basement of the northwest laboratory contains the manufacturing units, comprising foundry, heat-treating and mechanical plants, which last includes motor-driven rolling mill with 4:1 speed control, 150-ton steam, hydraulic power press and shearing attachment, driven by 150-horsepower air compressor, a motor-driven 10-ton chain drawbench with attachment for drawing tubes, and shop, with a 10-ton crane over all. The foundry includes both gas and oil fired crucible furnaces, 2 of 200 and 1 of 50 pounds capacity, core ovens, molding equipment, casting pits, etc.; a 150-kilovolt-ampere arc electric melting furnace of 600 pounds capacity is being installed, and it is hoped to be able to install a 1 or 2 ton open-hearth furnace; there is a laboratory attached to the foundry for research work on sands.

The heat-treating plant comprises 1 semimuffle oil-fired furnace 7 by 2 by 1½ feet, with quenching tanks of oil and water 12 by 3 feet provided with circulation pump, salt and metal baths, case hardening furnace, several gas and electric muffle furnaces of various sizes, 5 electric resistance tube furnaces, 2 electric melting furnaces for high temperatures, and there are being installed 2 large 50-kilovolt-ampere electric annealing furnaces to serve the rolling mill; one of these, 14 feet long, is designed for rods and tubes and the other for ingots. Additional furnace equipment for special researches includes 2 high-temperature vacuum furnaces with pumps, rheostats, and other accessories and a number of small furnace units.

For thermal analysis there has just been delivered an Einthoven galvanometer outfit which will be used in various experiments on the properties of rapidly cooled alloys. This section also possesses three complete sets of thermal analysis outfits and has recently designed and put into operation a new type of furnace determining transition points in alloys. New apparatus for determining electrical resistance of alloys has been installed and considerable auxiliary apparatus and supplies purchased, including porcelain, platinum, quartz, thermocouples, galvanometers, resistances, tools, etc.

Among the miscellaneous equipment an optical pyrometer including a micropyrometric outfit, apparatus for determining hardness, Brinell and a scleroscope, also new microhardness instruments are being designed; a 10,000-pound testing machine; a 30-foot-pound

impact machine. (The heavy mechanical tests are made by the Structural Materials Section.)

There is one room fitted up for physico-chemical research, electro-chemical analysis, and equipment for examination of fusible plugs. In addition to the general shop facilities of the Bureau there is attached to the Metallurgical Division a small shop containing saw, grinder, miller, drill press, and lathes. The electrical equipment for so much special apparatus is necessarily quite extensive and embraces several power lines with alternating current and direct current and a flexible set of transformers, rheostats, potentiometers, and other instruments, etc.

The metallographic facilities include adequate apparatus for cutting up, grinding, polishing, etching, and photographing metals. The laboratory possesses three metallographic outfits, a Zeies, Leitz, and latest Bausch & Lomb model, and a varied assortment of accessories.

In the laboratory of chemical metallurgy are large electric vacuum furnaces and auxiliaries for preparing pure metals; an outfit for electrodeposition of iron, etc.; furnaces and other equipment for preparing pure magnesia crucibles; apparatus for determination of gases in steel, several for rapid determination of carbon by composition and electrolytic method; furnace for preparation of pure aluminum; in addition to the usual chemical equipment.

Publications.

The practice has been continued of issuing circulars of information concerning metals and alloys. Thus a circular (No. 73) just issued on copper treats of its manufacture, physical properties, metallography, together with information concerning effects of temperature and of impurities on physical properties and contains a comprehensive bibliography. Circulars are in press or in preparation on "Aluminum and Its Light Alloys," "Solders for Aluminum," "Bearing Metals," "Acid Resisting and Noncorrodible Metals," "Protective Metal Coatings," and the circular on metallographic testing is being revised.

Pending the preparation in the more comprehensive form of printed circulars, information on certain subjects of general interest, or about which numerous inquiries are received, is disseminated in "circular letters." The following, prepared this year, are typical: "Sources of Information and Data on the Properties of Metals at High Temperatures," "Mechanical Tests of Metals and Alloys and High and Low Temperatures; Sources of Information and Data."

The following papers by members of the Metallurgical Division have appeared during the year: Typical Cases of the Deterioration of Muntz Metal by Selective Corrosion, Bureau of Standards' Technologic Paper No. 103, American Institute of Metals, IX (p. 148, 1918); Some Unusual Features in the Microstructure of Wrought Iron, Bureau of Standards' Technologic Paper No. 97, Transactions of American Institute of Mining Engineers (p. 1345, 1918); Copper, Bureau of Standards' Circular No. 73, Metallurgical and Chemical Engineering (18, pp. 121, 192, 303, 357, 1918); Rapid Determination of Carbon in Steel by the Barium Carbonate Titration Method, Journal Industrial and Engineering Chemistry, (10, p. 520, 1918); Thermal Expansion of Alpha and of Beta Brass Between 0° and 600° C., in Relation to the Mechanical Properties of Hetero-

geneous Brasses of the Muntz Metal Type, Bureau of Standards' Scientific Paper No. 321, 1918, Journal American Institute of Metals (11, No. 3, p. 396, 1918).

The following are in press: Structure of Commercial Zinc Coatings, Proceedings American Society for Testing Materials, XVIII, 1918; The Use of Mercury Solutions for Predicting Season Cracking in Brass, Proceedings American Society for Testing Materials, XVIII, 1918; Second Report on Ladle Test Ingots, Proceedings American Society for Testing Materials, XVIII, 1918; Aluminum, Bureau of Standards' Circular; Solders for Aluminum, Bureau of Standards' Circular; Initial Stress and Corrosion Cracking of Brass, Proceedings American Society for Testing Materials, XVIII, 1918; A Critical Study of the Ledebur Method for Determining Oxygen in Steel.

The following are in preparation: Conservation of Tin in Solders, Bearing Metals, and Bronzes, American Institute of Mining Engineers; Circular on Bearing Metals; Circular on Acid Resisting and Noncorrodible Metals; Circular on Types, Properties. Specifications, and Tests of Metal Coatings; Manufacture and Testing of Tin Fusible Boiler Plugs; A Modified Sample Collecting Sprengel Pump; The Embrittling Effects of Metal Coatings.

Metallurgical Tests.

The tests of metals executed the past year have been mainly for the military departments, and many of them were of such elaborate character they will be classed as investigations. Of the more elaborate investigative tests may be noted: An examination of the characteristics of centrifugally cast steel—which gives promise of possibilities of advantageous use in replacing several lines of steel forging, cutting down discards, machining and segregation, and eliminating piping, blow holes, and forging; a study of strains in cartridge cases as dependent on manufacturing methods and the adaptability of accelerated stress-corrosion tests for predicting failure; the relation of grain size to distortion in cartridge cases; an exhaustive comparison of the relative merits of cold shearing and nick-and-break method for shell slugs; distinguishing between hard and soft rotating bands for shells; several tests of armor plate and numerous other materials for ordnance, aircraft, quartermaster and engineering departments of the Army and for the various branches of the Navy; fusible tin boiler plugs for steam vessels; recovery of tin; examination of a very large variety of coatings for rust proofing; interesting points were the nonuniformity in electroplated coatings, uniformity of sherardized coatings; brass plating, the relations among the metals showing the superiority of zinc; and a study of the "copper-clad" process; micro examination of large (12-inch) chain links forged, welded and cast, tarnishing tests on Benedict nickel and German silver; heat treatments presenting special problems were very small compass needles, large (30-inch) U-bars, long slender rods and very large sheets; service tests of the lead-base bearing metal, ulco; service tests of a special lead-base babbitt; investigation of cause of failure by cracking of brass locomotive steam gauges; cause of cracking of case-hardened aeroplane engine cam follows; failures of aeroplane crank shafts; service tests of rhotanium and palau (substitute for platinum) crucibles; corrosion tests on several acid-resisting alloys; tests of numerous

commercial light aluminum alloys; causes of cracking of welded Army aluminum canteens; determination of working temperatures of machine gun barrels; tests of magnalium alloys of high optical reflectivity for mirrors, including the preparation of a series of a considerable number of such alloys, a large number of steels and alloys were examined by thermal analysis to locate their critical points; the casting of numerous metals and alloys for instrument parts and researches; samples of meteoric iron for structural characteristics; numerous samples of platinum to determine purity and causes of deterioration; a very serious type of failure known as "flaky" steel occurring in nickel-chromium and nickel steel was studied in great detail; semisteel, cast iron and steel shells; failed gun forgings and other ordnance material to determine cause of failure, suitability for use or special characteristics; valves for aircraft motors; machine-gun barrels; German rifle bullets; cartridge clips, etc.

A summary of the metallurgical tests is given below; their total value in fees is \$7,090.50. Of these tests items, 90 per cent were for the various departments of the Government and 10 per cent for private individuals and corporations.

The activities incident to the carrying on of the war have made many temporary changes necessary in the research program; new problems have been taken up and work on the older ones has had in some of the cases of necessity to be for the moment discontinued.

	Heat treatment and thermal analysis.		Metallographic (including physical, chemical, and corrosion tests).					Fusible plugs.	Miscellaneous.	Grand total.
	Irons and steels.	Non-ferrous metals.	Irons and steels.	Aluminum alloys.	Brass and bronze.	Identification of metal and process of manufacture (metal coatings).	Other metals.			
For the Government:										
Bureau of Chemistry.....						5			4	4
Bureau of Entomology.....									1	5
Bureau of Mines.....									1	1
Bureau of Standards.....	118		6			6			25	155
Council of National Defense.....							1			1
District of Columbia.....					2					2
Emergency Fleet Corporation.....									1	1
Lighthouse Service.....									1	1
Navy Department.....			2	7	9	6	2		1	27
Panama Canal.....			15			57		9	1	82
Patent Office.....							2			2
Post Office Department.....						6				6
Smithsonian Institution.....			2							2
Steamboat-inspection Service.....								453		453
Treasury Department.....									3	3
United States National Museum.....			14							14
War Department.....	14		222	16	26	8	41		75	402
War Industries Board.....					1					1
Total.....	132		261	23	38	88	46	462	112	1,162
For the public.....	14		35	3	19	11	19		26	127
Grand total.....	146		296	26	57	99	65	462	138	1,289

Tests of New Alloys.

The war has brought out a number of new alloys, or modifications and processes with new names, which have been submitted for examination usually with view to their military utility. Some of these are: "Liberty metal," palau, rhotanium, various aluminum solders, acerial, magnalium, magnalite, McAdamite, cooperite, al-calcium, magnolia metal, ulco bearing metal, various metal coating processes, the alloys dirigo, bario, ampcos, cosmic, zelco, stellite, tinol, aterite, sperlite, Siliman bronze, etc.

Military Boards and Committees.

The International Aircraft Standards Board, organized August 8, 1917, with representatives of Canada, France, Great Britain, Italy, and the United States, has held most of its meetings at the Bureau of Standards. This board has done valuable work in reducing the number and unifying specifications for aircraft materials purchased in the United States. Eighty specifications, of which 67 covered metals, have been issued for the board by the Bureau of Standards. Several important lines of investigation have also been the outcome of the deliberations of this board.

The Emergency Fleet Corporation has organized a committee on Welding—in succession to others of the American Institute of Electrical Engineers, etc.—in which the Bureau of Standards was represented, and a distributed experimental program is under way.

The Advisory Committee for Aeronautics in November, 1917, organized a light alloys committee. Several important experimental contributions have already been made, mainly by the Bureau of Standards, on aluminum and its alloys, and others are in preparation.

On the National Research Council's foreign service engineering and body armor committees the Bureau of Standards was represented.

Various members of the Metallurgical Division have been called in as technical advisers by the several branches of the War Industries Board, particularly on tin, steel, and platinum, and the Bureau of Standards in consequence has undertaken considerable experimental investigation, especially on tin conservation and substitutes.

In addition to formal committees with regular programs, there have been held a great many conferences, at which the Bureau of Standards' representatives have been present, called by the various military department to discuss with manufacturers technical questions bearing on military materials and specifications.

Military Inventions.

The Metallurgical Division has assisted the several information, patent, and military departments in the examination and development of military inventions relating to metals, manufacturing processes, and various devices made of metals.

Information Furnished by Correspondence.

In addition to information furnished in personal interviews on technical subjects, there is a very heavy correspondence maintained on subjects relating to metals; that of the month of February, 1918, here reproduced is typical both as to range and number of subjects.

Information has been furnished by correspondence on the following subjects: To the Navy, resistance to corrosion of aluminum bronzes, criticism of bronze and brass specifications, corrosion of copper plated clips, bolts, sheets, etc., zirconium steels, nickel-steel for periscope tubes, oxyacetylene welding of steel pipes; to the Army, on quenching media for heattreating steels, noncorrosive metals, copper rotating bands for projectiles, sheet aluminum, steel for caterpillar treads of tanks, seamless and welded tubing, effect of mercury on primer metals, gun-metal tests, tests of brass-coated washers, on nickel-steel stock, melting points of brazing wire, nickel-plated sheets, advice as to publication of "steel in aviation;" to miscellaneous parties, silver-plated articles, use of aluminum scrap, substitution for tin in bearing metals, quality of fusible boiler plugs and substitutes, several items regarding welding processes, aluminum solders, electric conductivity of "bario" metal, etc., production of highest purity aluminum, a certain process of galvanizing, standard bronzes and bronzes, heat treatment of steel (several requests), optical pyrometers for metallurgical use, electrical welding of aluminum, manufacture of bronze powder, steel coated by "Episcassit" process, tempering steel, formulæ for galvanizing, galvanized culvert pipe situation, use of boron copper, bearing metals, physical properties of copper, aluminum, zinc, etc., (several requests), platinum substitutes, manufacturers of iridium and of tungsten steel, corrosion of iron and steel, methods of steel manufacture, alloys for aircraft, relative corrosion of metals, metals to take engraving for instruments, cobalt-chromium steel thermal characteristics, foundry mixtures for molds, silicon-bronze characteristics, brass formulæ, aluminum alloys and nonmagnetic alloys, corrosion of "alumoy," casehardening, specifications for Government materials (several requests), manufacture of small metal articles, material for aircraft engine valves.

MICROSCOPY OF METALS.

(The microscopic examination of metals and alloys, investigation of flaws, defects, and other imperfections in commercial metallic materials.)

Corrosion of Nonferrous Metals.

A contribution to this subject has been made in the form of a descriptive summary of typical cases illustrating this type of deterioration of metals. Much of this material has been submitted to the Bureau for examination during the past 4 or 5 years.

Protective Metallic Coatings.

In a study of the effects of rustproofing on the brittleness of wires, started at request of International Aircraft Standards Board, a preliminary examination was carried out with tensile tests of wires, taking the elongation in tensile test as a measure of the brittleness. While some conclusions as to effects of cleaning, plating, etc., could be drawn, the results were not sufficiently definite and a new form of test piece was required. It was decided to adopt the impact test, and an impact machine of the Izod type was designed and built. The experimental program covers the various compositions and sizes of wires in common use, and the investigation is to be extended to include especially the brittleness of small springs. In cooperation with the American Society for Testing Materials a joint program is

being carried out on zinc coatings, their properties, methods of test, structure, and effects of various coatings on the base metal.

Microstructure of Wrought Iron.

The study of the modifications which the presence of phosphorus may bring about in wrought iron has been completed and published. (Bureau of Standards Technologic Paper 97.)

Valve Steel for Airplane Engines.

Investigation of the effect of the rate of temperature change on the transformations and microstructure of an alloy steel used in valves for aeroplane motor very nearly completed. This investigation is expected to throw considerable light on the nature of hardening of steels and the properties of alloy steels. The results obtained will also contribute to theories of the hardening of steel.

Ladle Test-Ingot Investigation.

The second phase of this investigation as outlined in last year's report, has been completed and a report made to the American Society for Testing Materials. Aluminum treatment of ladle test-ingots was shown by this work to give nonsegregated ladle-test ingots of high and medium carbon steel, but such treatment has little advantage for low carbon steels. Recommendations were made as to adoption of desirable types of ladle test-ingots and as to a comparative study during the year at certain works of test-ingots made with and without aluminum treatment.

HEAT-TREATMENT AND THERMAL ANALYSIS.

(Determination by thermal analysis of critical temperature points and ranges in metals and alloys, and the heat-treatment of these materials.)

Iron-Carbon Transformations.

The investigation of the transformations in pure iron-carbon alloys is nearing completion. The results are of practical as well as theoretical interest, as they form a basis for estimating the temperature of the transformations in steels by chemical analysis, which will eventually eliminate the necessity for commercial apparatus for this purpose, and they give a sound basis, which at present does not exist, on which to construct a theory of hardening.

Preparations are being made for the determination of the transformations in pure iron-carbon alloys containing various alloying elements.

New Furnace for Thermal Analysis.

A furnace of a new type for obtaining thermal curves has been constructed at the Bureau. This furnace makes it possible to do at least twice as much work in a given time as previous equipment, it uses a very small fraction of the power previously required, and a much greater temperature range and variation of rate is obtained with a more uniform curve than was formerly attainable. This will be described shortly.

Gun Erosion.

In cooperation with the Ordnance (Army) Department a comprehensive investigation is being made of the various factors affecting gun erosion, particularly as applied to machine guns.

PHYSICAL PROPERTIES OF METALS AND ALLOYS.

(Determination of physical properties of metals and alloys; correlation of physical properties with structure and constitution, and effect of temperature, mechanical working, etc., upon these properties.)

Light Aluminum Alloys.

One of the most important investigations taken up because of its military importance and urgency was that of the technical phases of the manufacture and the properties of the light alloys of aluminum, both wrought and cast. Such alloys are of especial significance in connection with the design and construction of aircraft, for which their lightness and strength well fit them.

In order that this work might constantly best serve the needs of the military departments, close contact has at all times been maintained with them, both through the Light Alloys Committee of the National Advisory Committee for Aeronautics and by personal conferences. Confidential reports have been issued from time to time—five to date—of the progress of this work.

One of the interesting results of this work has been the demonstration of the necessity for thorough investigation of fundamental facts and phenomena as the only satisfactory basis for technical progress in the art of manufacture. Thus, at the outset, interpretation of tests results was confronted by an almost total ignorance on the part of our present day metallurgy of some of the most fundamental physico-chemical data of aluminum and its alloys. As the technical phases of the work have proceeded therefore, the theoretical phases, such as constitution, etc., have required more and more attention, until at present it appears that further progress depends upon the solution of several of these fundamental questions.

Several directions have been followed in this work:

Aluminum-Rich Alloys of the Three Ternary Alloy Systems.—This is a study of the possibility of developing better commercial rolling alloys for use in structural construction. A survey was made of the mechanical properties of the rolled aluminum-rich alloys of each of these alloy systems. From 8 to 12 compositions of each system were cast and rolled into sheet at the New Kensington plant of the Aluminum Company of America, a representative of the Bureau directing both the preparation and subsequent testing of the samples. The copper series proved so superior in respect to mechanical properties in these tests that the other two series are practically eliminated from further consideration for purposes for which high strength is desired; only this series, also, is to any extent subject to heat treatment. The results of this investigation are described in Confidential Report No. II. The investigation is completed.

The Heat Treatment of the Duralumin Type of Alloy.—Heat treatment of the alloy known commercially as duralumin has been practiced for several years, but apparently little improvement has been made in the actual heat treatment practice since the initial discovery of this property of the alloy by Wilm. The Bureau's investigation of this question has led to some very interesting discoveries bearing on the theory of the effect of this treatment and to important alterations in existing practice of commercial heat treatment, resulting in improved physical properties and reduced wastage from cracking

during treatment. These alterations have been adopted commercially. Confidential Reports Nos. III and IV have been issued dealing with the results of this work.

The investigation is almost complete, but further work will be done (1) to clear up more definitely the theory of hardening by heat treatment, and (2) to ascertain the best heat treatment for the production of an alloy most resistant to alternating stresses.

Light Aluminum Alloy Castings.—Tests are being made of different casting alloy compositions, cast in the Bureau's foundry, (1) to discover alloys which will give better mechanical properties than those in use at present, (2) to study the effect of heat treatment on these alloys, (3) to ascertain the effect of the impurities, iron and silicon, on the properties of the alloys in the cast form, and (4) to study the effect of melting and casting temperatures on those properties. To date about 40 heats of metal have been poured and tested and the results are indicative of the possibility of obtaining alloys which are both harder and at the same time more ductile, hence tougher, than those in use to-day; this is accomplished both by the choice of a more suitable composition and the application of heat treatment.

This work is being continued on ever increasing scale, as there is a strong and growing commercial and military demand for better casting alloys.

Alternating Stress Tests of Duralumin and of Commercial Light Aluminum Casting Alloys.—The use of both rolled duralumin and of aluminum casting alloys in aircraft construction demands a fuller investigation into the resistance of these alloys to alternating stress than has ever been attempted hitherto. The materials for this work have been assembled or produced at the Bureau, and many of the tests made; the more rapid progress of this work only awaits the completion of the remaining 5 testing machines at the shops.

The Corrosion of Some Aluminum Alloys.—Tests are being made and are almost completed of the corrosion of different compositions of both rolling and commercial casting alloys in the salt spray test. In connection with (6) below, also, exposure tests in sea water have been undertaken of rolled duralumin in comparison with steel, copper, and brass. The results of these latter tests will naturally not be available for several months.

The Protection of Duralumin Against Corrosion.—With the cooperation of the Navy Department and of the Aluminum Company of America exposure tests in sea water have been planned and are about to be executed of duralumin coated with various types of paints and varnishes. The results of these tests will indicate how readily possible the protection of this metal by paint is, and are desired chiefly for the information of those interested in aircraft design and construction.

The Constitution and Metallography of Light Aluminum Alloys.—The necessity for clearing up a number of questions relating to the structure and constitution of aluminum and its light alloys has become increasingly apparent as a basis for further progress in the art of the manufacture of the alloys, and has led to the undertaking of the determination of (1) the structural identity of the constituents of the alloys of aluminum with iron, silicon, copper, magnesium,

manganese, and nickel, and (2) the solubility at different temperatures of these constituents in aluminum in solid solution. Much of this work is completed and one confidential report (No. V) gives the solubility curve of CuAl_2 , the aluminum-rich compound of the copper-aluminum series. These results, when complete, together with the data of previous investigators, will practically complete our knowledge of the constitution of the aluminum-rich alloys of these metals, and will serve to direct further work in the choice and development of commercial alloys.

The work to date has shown the superiority in strength of both casting and rolling alloys, of either zinc-copper or magnesium-copper as an addition to aluminum. The National Physical Laboratory is studying the zinc-copper combination, as far as rolling alloys are concerned; therefore our further efforts will be to improve the duralumin type of alloy, either by slight alteration of composition or by alteration of heat treatment.

The study of quite new rolling alloy compositions is considered unnecessary for the present.

One further problem that will be undertaken will be the possibility of spot welding duralumin.

At present beams and other structural members of duralumin for aircraft construction are assembled by riveting. It would be desirable as expediting production of such members to assemble by spot welding if this process could be shown to produce some reliable joints.

Magnesium-Aluminum Alloys for Mirrors.

There is under way an investigation for two branches of the Army, an investigation of possibilities of producing large mirrors of the magnesium-aluminum or magnalium type of alloy preserving high reflecting power and sufficient strength and of nontarnishing properties. Considerable success has been attained.

Investigation of Railway Materials.

Owing to the demands upon the time of those engaged in this work, made by work of a more urgent nature, there is little progress to report upon these investigations, which were described in detail in last year's report. The following are, however, nearly completed: Study of internal transverse fissures in rails; the heating stresses in car wheels; the distribution of temperature in cooling rails; the decomposition of cementite in cast iron by annealing, and the investigation of ingot practice, including chemical and metallographic surveys of several ingots, blooms and rails made by various processes. The installation of new apparatus and equipment will greatly facilitate the prosecution of this work.

The Failure of Brass.

Two important phases of this subject are still under investigation. The thermal expansivities of pure beta and of pure alpha brass of composition found in heterogeneous alpha-beta brasses have been determined from room temperature up to 600°C ., and a difference in these expansivities discovered sufficient, if fully effective, to produce moderately large initial stresses in a heterogeneous brass upon cooling rapidly from the upper temperature. The effect of such

stresses upon the tensile properties of 60 to 40 brasses was studied. The results of this investigation are embodied in Scientific Paper No. 321.

Twelve samples of drawn manganese bronze rod have been exposed for over a year while under tension, of known value, to corrosion by water. The results of these tests will determine the safe limits of stress allowable in this material when used for construction purposes such as bolts, and exposed to atmospheric or water corrosion.

These tests are being continued; more test frames are being built and naval brass will be added as a test material, and the effect of combined externally applied and initial stress will be studied.

Considerable work has been done in connection with brass cartridge cases submitted for metallographic examination by Ordnance Inspection Division and some manufacturers in testing out various solutions and in determining the effect of other conditions upon the indications of this test—size of sample, condition of surface, etc. In addition to the routine examination sufficient work was done to warrant embodying the results in printed form. This work should be continued when our rolling mill is in working shape and material of known preparation and physical properties can be readily obtained.

Acceleration Tests for Season Cracking and for Initial Stress.

With the aid of the new drawbench rods will be produced with varying amount and distribution of initial stress. These will be tested for both season and accelerated corrosion cracking (in mercury salt solution). The results will define the possibility of season cracking more definitely than heretofore both in terms of initial stress and of the results of the accelerated corrosion tests.

The Elimination of Initial Stress by Annealing.

The object of this investigation is to determine the temperature limit and periods of annealing necessary for the elimination of initial stress in different compositions of brasses. In rods of simple section initial stresses, producing season cracking, are most readily eliminated by the process of springing, such as by rolling in a straightening machine, but this method can not be applied to articles of irregular shape, stampings, etc., for which annealing may be necessary.

Arc Welding.

In cooperation with the Electric Welding Committee of the Emergency Fleet Corporation, an extensive program of investigation and tests of arc welds of ship plate has been undertaken. Besides usual tests which will be made by Division VII-1, special study will be made of the causes of brittleness in such welds and of the means for producing sound welds. This work is just beginning to get under way, and materials and welded specimens are being furnished by manufacturers.

Fusible Metals and Alloys.

The manufacture of fusible plugs.—This investigation is almost concluded. Some of the final conclusions are:

1. For casings material only bronzes of one of the following compositions should be used:

	I.	II.
Cu.....	88	87
Sn.....	10	7
Zn.....	2	5
Pb.....	.....	1

2. Before pouring on the tin the casing should not be heated to over 300° C., while the casing should be tinned on the inside before pouring.

The effect of small amounts of impurities on the melting point of tin is now being studied. Antimony in small amounts, up to about 0.25 per cent lowers the melting point slightly, while quantities above 0.25 per cent raise the melting point considerably. The effect of copper, zinc, and lead is now being studied.

Aluminum Solders.

An investigation of a few commercial aluminum solders, and also some specially made up at the Bureau, has been completed. The results obtained are:

1. A soldered aluminum joint is rapidly attached when exposed to moisture, and is disintegrated due to the fact that the soldering alloys are all electronegative to aluminum.

2. Joints made by soldering should always be protected against this disintegration by either painting or varnishing, except in case of very heavy joints, such as repairs to castings, where corrosion at the joint surface would be of little consequence.

3. Solders should be applied without flux, and their composition may be varied within very wide limits. The two following general types are recommended:

	I	II
Zn.....per cent..	15-50.....	8-15.
Al.....per cent..	.....	5-12.
Sn.....	Remainder.....	Remainder.

4. The higher the temperature at which the "tinning" is done the better the adhesion of tinned layer.

5. The joint between previously tinned surfaces may be made by ordinary methods, and with ordinary soft solder.

Tin Conservation.

All the tin used in the United States is imported, and there appearing a threatened shortage the Bureau has assisted the War Industries Board, after conferences and extended correspondence with manufacturers and consumers of articles containing tin, in making a program of limitation in its use and development of substitutes. The experimental work has followed the lines of finding suitable solders, reduction of tin in bearing metals, modifying bronzes, and recovering tin scrap. Suggestions to the Government departments concerning modification of specifications to conserve tin have also been made.

Cadmium Solders.

From the investigation as it has progressed so far it was found that cadmium solders of the following compositions:

	I	II	III	IV
Pb.....	90	80	85	75
Cd.....	10	10	10	10
Sn.....		10	5	15

may be used to solder tin plate, terneplate, brass, and copper as the ordinary tin-lead soft solders. The manufacture and use of the 90-10 mixture is rather difficult, due to the extreme ease with which it oxidizes in the molten condition. The preferred composition is 80 per cent Pb, 10 per cent Cd, and 10 per cent Sn, and it has been tried out with success on roofing materials, tin cans, and tests on fire-extinguishers and automobile radiators are now in progress.

Bearing Metals.

Service tests of different compositions of bearing metals have been made with a view of determining the adaptability of certain lead-base babbitts hardened with alkali or alkali-earth metals. It was found that in some respects they were superior to genuine babbitt and their use is being recommended in certain cases.

The information assembled on this topic and the few tests which have been made on special bearing metals indicate a need for a systematization of our ideas concerning bearing metals in general, the advantages and disadvantages of different types, as well as some more extended study of the behavior of different compositions of both babbitts and bronzes in service. A circular is in preparation dealing with bearing metals, and upon its completion a program of bearing metal investigation will be mapped out.

Metals at High Temperatures.

It is hoped to be able to carry out experiments on interrelations of stresses and strains and the phenomena of annealing and hardening including effects of sizes and geometrical shapes, as well as more thoroughly quantitative studies of mass as related to heating and cooling rates.

Another problem to be taken up is that of the tensile properties of metals at high temperatures.

The constantly increasing use of metals and alloys at elevated temperatures, such as in turbine blades, pistons, etc., demands a thorough investigation into the physical properties at higher temperatures. Particularly a knowledge of the stresses which will be borne by metals and alloys at these temperatures without yielding is desired on every hand.

Apparatus has been designed for this work, which it is hoped, will be continued in the near future.

In a study of the heat treatment of various high-alloy steels, it is hoped to determine more completely the relations among the alloys in their effect on iron alone, and to proceed from that to the steels.

In the quenching of steels, quenching data in the literature refer to "quenching in oil," "in hot water," etc. It is proposed to put all such treatment in a standardized basis, e. g., "a cooling rate of 93° C. per second through the transformation range," etc., such data being obtained by use of the Einthoven galvanometer. Studies of grain size, hardness, and difference between inside and outside of specimen will be included.

The quenching speeds of various quenching media are also to be studied, to add to the somewhat meager data now available. The conditions which make for deformation of long, slender rods in quenching will also be studied.

Copper Plugs for Testing Cartridge Powders.

At the request of one of the powder companies the preparation, manufacture, and testing of copper plugs for control of cartridge powders is being planned. It appears that the uniformity of these plugs is very uncertain and the standard variable. It is probable that greater attention will have to be paid to grain size, conditions of annealing, freedom from oxide, and other factors.

Metals for Instrument Parts.

A study is being inaugurated of the composition and thermal treatment of metals suitable for certain aeronautical instruments, such as recording barometers, altimeters, etc., with the object of diminishing the elastic aftereffects which are usually so troublesome.

Preparation of Metal Specifications.

In addition to the specification work of the American Society for Testing Materials and of the International Aircraft Standards Board, the Metallurgical Division has assisted the several Army and Navy technical bureaus and the British Imperial Munitions Board in drawing up metal specifications, and a great deal of testing and experimental research has been carried out in connection with defining and fulfilling specifications. This work has necessitated innumerable conferences with military officers and has been undoubtedly one of the most useful phases of this year's work, as it certainly is one of the most far-reaching.

From our experience the past year it would seem wise to endeavor to establish a single board for metal specifications for specifications for the Army, on which the Bureau of Standards should be represented; there is at present considerable duplication of effort and confusion and some of the military departments need the advice and experimental facilities the Bureau of Standards can offer.

A very complete set of American metal specifications was furnished the French War Ministry's Committee on Metallurgical Standards.

METALLURGICAL CHEMISTRY.

(Preparation of metals and alloys from their ores; development of analytical methods for iron and steel; and preparation of pure metals.)

Electrolytic Carbon Method.

The method as outlined in last year's report has been further improved and simplified. A special procedure for determining electrolytic resistances has been developed, in which use is made of commercial 25 or 60 cycle alternating current in connection with the

Weibel galvanometer as a zero instrument. This method has proved much more satisfactory and is much simpler than the high frequency alternating current generator and telephone as zero instrument formerly used. A simplified gas absorption vessel with an adjustable cell constant replaces the fragile absorption apparatus used last year; this has the advantage over the latter of robustness and of being easier to build and easier to keep in working order. An improved chart for reading carbon percentage from the observed resistance and temperature has been devised. This replaces cumbersome tables and series of curves previously used for this purpose, and at the same time is more accurate. It is believed that this apparatus is now in its final form, and a set of 6 outfits for commercial use is being built. By this method an accurate determination of carbon in steel can now be made in $4\frac{1}{2}$ minutes.

Rapid Determination of Carbon in Steel by the Barium Carbonate Titration Method.

Means for increasing by 50 per cent the output of work when using this method are described in a paper in the *Journal of Industrial & Engineering Chemistry*. This paper describes the investigations made at the Bureau for increasing the speed of this method without much sacrifice in accuracy.

Nitrogen in Steel.

Several experimental forms of apparatus for the absorption of the nitrogen of this method have been built and tried. The most promising form is a steel test tube cooled by water jacket at the top and heated by an electric furnace to 800° to 900° . This tube incloses a hard glass test tube which contains a calcium inclosed in another iron tube. The space between the scale and glass tubes is evacuated to 20 to 30 millimeters before heating, and the collapsing of the glass tube is thus prevented; the glass tube is evacuated to 0.01 to 0.001 millimeter before heating. This apparatus is joined to the gas burette containing the nitrogen and to a McLeod gauge and the absorption of the gas followed by change of pressure. One hard glass tube serves for many determinations.

Goeren's Method for Determining Gases in Steels.

An electric vacuum furnace for this work, with carbon resistor and having special features, is now about complete in the shop. A satisfactory new form of sample-collecting mercury pump has also been built and fully tested. The pump originally intended for this work has undergone several modifications in the glass-blowing shop, and it is hoped that this will now be satisfactory. Several practical applications of this method of determining gases in steels are indicated by recent metallurgical problems brought to the Bureau by military departments of the Government and by commercial firms, and it is expected that much progress will be made in these studies during the coming year.

Determination of Gases by the Goutal Method.

Before completing the intended paper on this subject announced in last year's report, it was thought advisable to check some of the results previously obtained, using specially prepared reagents and

extra precautions. The results of this additional work fully confirmed the earlier conclusions.

Critical Study of the Ledebur Method for Determining Oxygen in Steel.

In this case, also, it was thought desirable before publishing the paper to make some searching investigation of certain sources of error, which work required several weeks. The work is now considered complete and the paper is in the hands of the Bureau Editorial Committee.

Oxygen Content (by the Ledebur Method) of Steels Deoxidized in Various Ways.

The work referred to in last year's report has been completed as to oxygen determination, and physical tests of this steel so prepared are about to be made. The chemical work indicates that the various methods of deoxidation used—namely, ferromanganese, ferrosilicon, aluminum, and titanium—have yielded steels with oxygen contents nearly identical, as shown by the Ledebur method.

Equilibrium Between Iron Oxide, Carbon, and Hydrogen.

The work on the Ledebur method, already referred to, made necessary an investigation of certain questions connected with this equilibrium. This work has now been completed and a paper describing it is being prepared. As a result of this investigation it is shown that carbon alone (as iron carbide in this case) reduces ferrous oxide at 800° to 900°, with formation of carbon monoxide and dioxide; as soon as hydrogen is introduced there is a partition of the reducing action between the hydrogen and carbide and the proportions of the reduction products (carbon dioxide, carbon monoxide, and water vapor) formed vary with the rate of passage of the hydrogen. With very low rates not more than 20 per cent of the iron oxide is reduced by that gas; a rate of not less than 4 liters per hour is necessary to effect a 90 per cent reduction by hydrogen alone. This investigation showed among other things, that the rate of hydrogen passing in the Ledebur method should not be less than 40 liters per hour.

Determination of Carbon Monoxide as Obtained from Steels.

Carbon monoxide is an important constituent of the gases extracted from steel when this metal is melted in vacuo. Certain hydrocarbons, produced by secondary reaction, are also present in these gases. Consequently, in order to determine carbon monoxide in such mixtures it is desirable to find a combustion method which will burn the carbon monoxide without affecting the hydrocarbons present. Tests have been made of a method using copper oxide at 250° as oxidizing agent, and it has been shown that fractional combustion of carbon monoxide is successfully effected in this way, provided unsaturated hydrocarbons are absent. Absorbents for the latter are now being investigated and it is believed that suitable ones have been found. A special form of electric furnace for heating several copper oxide reaction tubes in series has been designed and used for this work.

Special Alloy Work.

The apparatus for producing electrolytic iron and melting it in vacuo has been moved to the new chemistry building where it has been installed with improvements and additions and is now produc-

ing. The vacuum furnace for producing large ingots has been improved until it is now satisfactory. Difficulty was experienced in making crucibles of the tall narrow form wanted for melting pure iron-carbon alloys, this being due to the fact that no clay or other binder containing silica could be used for bonding the pure magnesia, on account of the contamination by silicon of melts made in crucibles so bonded. This difficulty was not met in our previous work where smaller quantities of iron were melted. Magnesia, unfortunately, has little strength of high temperatures, so that a bond of some kind is necessary. Our investigations have shown that alumina can probably be used successfully as a binder and careful analyses have thus far shown no contamination of the melts by reduced aluminum. Crucibles are either molded under pressure and placed in supporting crucibles of Acheson graphite or a lining of the magnesia-alumina material is rammed into an Acheson graphite crucible. Several large vacuum melting ingots have been produced. The present procedure for making such ingots, devised during the past few months, consists in melting in a gas-fired furnace the electrolytic iron mixed with enough pure carbon to saturate it (in order to secure a low melting point alloy). The crucibles used for this work are commercial plumbago crucibles protected by a rammed-in liner of pure Acheson graphite powder bonded with glucose. The iron-carbon alloys so produced are melted in the vacuum furnace, together with enough pure iron and iron oxide to lower the carbon content to whatever is desired.

Some method of premelting the electrolytic iron before melting in the vacuum furnace, such as that just described, is very desirable, since not enough of the unmelted electrolytic iron can be introduced at one filling of the vacuum furnace to make an ingot of the size wanted, and the vacuum furnace can not be opened for refilling until it is cool, which is wasteful of time and current.

As soon as a sufficient number of iron-carbon and pure iron ingots are produced these will be used as starting materials for the manganese-iron-sulphur carbon investigations described under the section of this report: "Manganese and Deoxidation Researches."

Improvements in the Bureau's methods of making pure magnesia with a view to substituting the now very expensive acetic acid are being investigated with some promise of success.

Pure Aluminum.

Researches at the Bureau of a military character have shown the possibility of obtaining remarkable properties in the metal and its alloys by the use of aluminum purer than that commercially supplied. Accordingly, special apparatus has been devised and materials have been assembled at the Bureau for carrying on an investigation with this end in view. The apparatus for electrolysis consists of a steel crucible lined with a pure Acheson graphite liner for holding the electrolyte and a gas furnace for keeping the contents of the crucible molten. A movable Acheson graphite rod set axially in the crucible serves as anode, and the crucible is arranged so the aluminum can be tapped off as desired. As soon as some uncompleted shop work is done the preparation of aluminum will be begun.

Plans have been devised for making still purer alumina if this is found to be desirable.

Manganese and Deoxidation Researches.

The proposition for an investigation of the use of manganese and other agents for the deoxidation of steel, with a view to conservation or substitution of manganese, with proposition originated in this Bureau as being very desirable from a military point of view, has been much extended. The Bureau of Mines and the National Research Council are now cooperating on this problem and the cooperation of other agencies is being enlisted.

As has already been emphasized in special reports on this subject, manganese is an essential element in present processes of making steel and the domestic supply of manganese ores is so inadequate that there is serious dependence on foreign sources, which is dangerous in war times. Hence, conservation of, and substitutes for, this metal are highly desirable.

Oil-Proofing Concrete Liners.

At the request of the Emergency Fleet Corporation work has been started with a view to finding means for rendering concrete ships impervious to light mineral oils. The methods suggested consist in covering with lead sheets, cast lead, sprayed lead, shellac, neat cement shot from a gun, barium sulphate, sodium silicate. Experimental investigations are being started on what seem to be promising lines.

FOUNDRY.

(Experimental and practical castings of metals, including special alloys for research and specialized purposes and practical foundry research.)

Foundry Investigations and Tests.

The investigation of casting methods and types of test bars as carried out by five foundries in an identical program and using metal cast in one heat has been completed and the physical properties of the brass determined. The metals used were Government bronze (88 Cu, 10 Sn, 2 Zn) and a modification containing 88 Cu, 8 Sn, 4 Zn. The results are ready for publication.

The effect on the physical properties of small additions of various metals to Government bronze is being studied systematically, and similarly for addition to aluminum. Special alloys suitable for castings are also made and examined as requested.

The type of test bar for different nonferrous alloys is being investigated.

The foundry serves the Bureau and the research laboratories of other departments and Washington institutions in preparing a great variety of kinds and types of metal and alloy castings. The new quarters have greatly extended its possibilities for service and research.

Sand Investigations.

This question has been taken up anew with regard to (1) reclaiming "burnt" steel foundry sand, (2) the production of artificial sands and establishment of standards, and (3) development of tests of sand qualities. The first has already given promise of demonstrating to

some foundries the reclaiming of 90 per cent of the sand at a reasonable cost. The Washington Navy Yard foundry and others are co-operating in this work.

Experimental and Practical Casting.

The foundry has made the following castings for experimental and special technical uses.

Metal.	Castings.	Patterns.	Weight.
			<i>Kg.</i>
Aluminum alloy.....	255	76	138.63
Brass.....	241	84	420.75
Bronze.....	1,701	334	1,244.50
Cu-Mn-Ni alloy.....	1	1	12.00
Copper.....	6	4	132.00
Lead.....	10	5	33.70
Silver alloy.....	1	1	6.66
Tin.....	21	3	39.50
Zinc.....	13	8	424.53
Total.....	2,249	516	2,452.27

9. CERAMICS.

[Development of new uses for clays; replacement of imported by native materials; improvement of quality of products; designing and conducting tests for quality; standards of quality; routine tests for Government purchases; acting in advisory capacity as to conservation of fuel and transportation for ceramics; acting as clearing house for collection and dissemination of information.]

CLAY PRODUCTS.

(Investigation of building tile, and other clay products; industrial and educational cooperation; design of new equipment; development of enamels for iron and copper; studies of kiln efficiency; new uses for clay products; improvement of quality of products; manufacture of certain porcelains for Government use.)

Investigation of Building Tile.

The report covering the investigation of building tile is in the hands of Publication Committee. This report presents the results of compression and absorption tests on several hundred hollow building tile. The strengths in compression varied from 4,000 to over 10,000 pounds per square inch of net section of tile when tested on end, and approximately from one-half to three-fourths of these amounts when tested on edge or flat.

The tile absorbed from 4 to 11 per cent of water. The relative absorption power of a tile gives a fair indication of its strength, a vitrified tile absorbing least water, being hardest, and carrying the greatest compression load.

Industrial Cooperation and Dissemination of Technical Information Concerning Ceramic Products.

Cooperation is being maintained by the Bureau with many concerns and individuals with reference to industrial problems, both by correspondence and consultation. The volume of this work is constantly growing larger. Extensive cooperation is being conducted also with a number of technical organizations, such as the National

Brick Manufacturers' Association, the National Hollow Tile Manufacturers' Association, the National Terra Cotta Society, the Refractories Manufacturers' Association, the United States Potters' Association, the American Society for Testing Materials, the American Ceramic Society, etc.

Design of New Equipment.

All of the drawings for the new kilns, furnaces, and machinery to be erected in the new ceramic laboratory now under construction at Washington have been practically completed.

Enamels for Copper.

Work has been begun on enamels for copper as applied to dials to watches, scientific instruments, etc., for the purpose of displacing the enamels formerly imported from Germany.

Iron Enamels.

Two papers have been completed dealing with the subject of vitreous enamels applied to cast iron and steel. Since the literature dealing with this important industry is exceedingly meager, these contributions, which are voluminous and partake of the character of textbooks, should prove of considerable value to manufacturers and others interested in enameling.

Efficiency Studies of Ceramic Kilns.

A paper has been completed dealing with the study of the heat losses determined on a tunnel kiln and a down-draft kiln fired with producer gas.

The Use of Clay in Chemical Reactions.

Advice as to the best methods for selecting clays especially active in promoting certain gas reactions has been submitted to military authorities at their request.

Clay Aggregate for Concrete.

Work has been done in the production of a hard-burned but light clay aggregate for concrete for a special purpose with very satisfactory results, resulting in a concrete which is strong though of low lump specific gravity. Similarly, sand from crushed hard-fired clays was found to give good results.

Cooperation with the War Industries Board.

The services of the Ceramic Division have been called upon by the board upon the questions of replacing clays formerly imported from Europe, the proposed embargo upon English kaolins and ball clays, and the most economical distribution of refractories from the iron, steel, and coke industries.

Cooperation with the United States Fuel Administration.

Assistance is being rendered the Industrial Furnace Section in connection with a campaign aiming to bring about greater fuel efficiency in the firing of ceramic kilns, glass furnaces, etc.

Cooperation with the United States Potters' Association.

The Bureau has arranged with this association for an extensive study of possible combinations for white-ware pottery, using American clays exclusively. This work is to be done at 11 potteries in East Liverpool, Ohio.

Clay Survey.

Standardized tests of clays have been worked out for use in the general survey of the kaolin and clay resources of the United States, conducted by cooperation with the National Research Council, the United States Geological Survey, the Bureau of Mines, the Association of State Geologists, different State surveys, and the ceramic schools.

Pottery Saggars.

In the manufacture of pottery the breakage of the refractory containers (saggars) used to protect the ware during burning is a heavy item of expense. This is still more true in the manufacture of hard fire porcelain. By improving the quality of these refractories the manufacturing losses can be decreased very greatly. Work has been done in this connection, and the load carrying capacity of the saggars improved decidedly. These studies are being continued with reference to containers for special hard fire products like spark plugs, grinding wheels, etc.

Refractories for Marine Boilers.

A new type of refractory combining the qualities of porosity, light weight, and high refractoriness has been worked out and the results submitted to the Navy.

Work on Refractories.

The work done in the past justified an attempt to prepare general specifications for clay fire brick. As a result this was done and the proposed requirements for four classes of refractories submitted to the Refractories Manufacturers' Association, the Mellon Institute at Pittsburgh, and others for criticism. Checkwork done at the Mellon Institute has shown the specifications to be fair and reasonable.

Specifications for silica refractories are likewise being prepared.

A technologic paper on the subject of the sizing of calcined clay (grog) used in the building of refractory bodies has been published. It was shown that the density and strength of fire-clay materials hinge to a considerable degree upon the proper combination of sizes of grain.

Another technologic paper dealing with the structure and the manufacture of silica refractories is being printed. Similarly, a paper giving the results of tests upon 60 brands of American fire brick has been completed.

Refractory Porcelain.

Continued progress has been made in the development of refractory porcelain, formerly obtained from Germany, and the technique has been perfected so that it has been possible to make pyrometer tubes over 7 feet long.

Spark Plugs for Airplanes.

In cooperation with the Washington laboratory of the Bureau of Standards an extensive research was undertaken for the purpose of producing a porcelain-like body which shows a high electrical resistance at temperatures up to 600° C. and at the same time good mechanical strength when subjected to shocks and sudden heating and cooling. Such a body has been produced and is now being worked commercially. It has been shown in this work that the presence of feldspar is particularly injurious to the development of high electric resistance at the temperatures to which spark plugs are carried. This mineral constituent has therefore been eliminated. At the same time, the content of sillimanite in the finished porcelain has been greatly increased by the use of suitable calcines.

Crucible Clays.

Additional work has been done in the study of suitable clays by making up several sets of crucibles from different mixtures of typical clays and graphite. The most promising compositions resulted in a life of the crucible yielding from 25 to 30 melts.

Architectural Terra Cotta.

A large majority of the manufacturers of this decorative building material have submitted samples of their product to the Bureau for the purpose of determining the general physical properties. These samples were in the form of a specially made open box and also in the form of pieces left over from structures built by the manufacturers. There were thus obtained for testing, pieces especially made for testing purpose and pieces made in the ordinary course of manufacture. These were tested for strength in compression and their ability to withstand both natural and artificial freezing (produced by the crystallization of sodium sulphate). In addition the absorption at various periods was determined.

While in general the results show that increased strength is accompanied by decreasing absorption and increasing ability to withstand freezing, yet there were such exceptions to the statement that further work is necessary, especially in investigating the burning of the clays used. It was gratifying to find, by the compression tests, that practically all the pieces were able to withstand stresses greater than those which would be imposed upon them in structures. It was also found that test pieces specially burned for testing purposes, do not frequently give a true indication of the properties of the material burned as a piece for structural purposes.

Hard-Fire Porcelain.

The study of this subject has been prosecuted vigorously and a large amount of data has been obtained. Over 120 porcelain compositions have been made and tested. It has been found possible to fix the limits of composition for the several types of porcelain and to demonstrate the effect of the reducing or oxidizing conditions during firing. Particular attention has been paid to the subject of chemical porcelain and a new type of body produced which possesses valuable properties. Cooperative work in this connection has been done

with two manufacturing concerns. In one case it was found possible to improve the quality of the product decidedly as well as to increase the yield of the first-class ware.

Particular attention has been given to the development of a true hard-fire porcelain from American materials and assistance has been rendered prospective manufacturers to make the new industry possible. One pottery of this type is already in course of construction and the new development should result in the elimination of such porcelain imported formerly from Austria and Germany.

GLASS.

(Examination of raw materials for glass and for glass pots; development of improved methods for making glass pots; design of plant for manufacture of glass pots on large scale; manufacture of a particular quality of optical glass on large scale for Government use.)

Examination of Raw Materials for Optical Glass Manufacture.

A large number of samples of sand, potash, soda ash, limestone, lead oxide, barium carbonate have been analyzed with reference to their content of impurities which are objectionable for the production of fine optical glass.

Casting Process.

Owing to the desirability of replacing expensive hand processes by quicker methods the question of making glass pots, crucibles, etc., by pouring the liquid mass into plaster molds was taken up and solved successfully. Owing to the heavy and massive articles thus to be made special mold constructions and means of handling had to be worked out. A plant for casting heavy ware was erected which is capable of producing 2 to 3 glass pots per day. The economic phases of the process were studied in detail and drawings prepared showing the arrangement of machinery and accessory apparatus, together with a description of the manipulations involved. This information has been given to 5 producers of glass pots, and is available to any concern which is interested.

Glass Pots.

One of the fundamental problems connected with the production of optical glass is the use of pots resistant to the corrosive action of these glasses and very low in iron content. For this reason the clay products laboratory has devoted considerable attention to this work with the result that a very satisfactory composition of the nature of porcelain has been worked out, which resists even the violent corroding action of the heavy barium glasses. Since the commercial pots are entirely unsuited for this purpose, instructions concerning the composition and making of the porcelain pots thus developed have been imparted to 5 commercial concerns, of which 3 are now producing them. These data have been published also in articles appearing in Metallurgical and Chemical Engineering and the Journal of the American Ceramic Society.

It has been found possible also to reduce the cost of the porcelain pots by making use of the bisque waste from white ware potteries, which formerly was thrown away or sold at a negligible figure. Since this material makes up practically one-half of the composition the cost of the white glass pots is about the same as that of the ordinary ones. The porcelain pots are being made at the Pittsburgh laboratory both by the usual hand molding and the casting methods.

The porcelain composition is being used also for the stirring rods required to mix the fused glass.

Optical Glass.

The optical glass laboratory erected during the summer of 1917 is now in operation and during the year 200 melts have been made in large pots. Eight gas-fired furnaces are in operation, with the necessary complement of heating, softening down, and annealing furnaces. About 5 melts of glass are being made per week. The processes of manufacturing optical glass have been mastered in practically every detail and 7 types of optical glass have already been made varying in index of refraction from the lowest to the highest values.

The problem of surfacing glass has also been studied and a set of machines for grinding and polishing has been installed. Much study has been given to the problem of rapid though rigid inspection and apparatus installed at the Pittsburgh laboratory, at the plant of the Pittsburgh Plate Glass Co., and of the National Optical Glass Co., at Washington, Pa. The Bureau of Standards laboratory advocates inspection through the edges of the glass plates as being more rigid and detecting imperfections, such as striæ, which readily escape observation when the glass is examined flatwise.

The Pittsburgh glass laboratory ships monthly more than a ton and a half of rigidly inspected glass. For the purpose of utilizing small pieces of good glass a press has been set up for making the blanks of small lenses. Additional presses for making prisms and other blanks are about to be installed. In addition to the productive work, researches in connection with improvements in the manufacture of optical glass are being conducted constantly and the mass of information thus accumulating is certain to be of great value in establishing all the details of production on a firm basis, a condition which will assist in making this country independent of any German supply of optical glass.

Cooperative work was conducted with 3 commercial plants with reference to the production of optical glass and with 6 factories in connection with manufacturing problems relating to staple articles.

Work has also been done on special colored glasses for special applications and on the problem of producing glass for artificial eyes, all of which has been successful.

All plans and designs for the new glass laboratory now being built on the grounds on the Bureau of Standards at Washington have been completed and the contracts signed.

LIME, GYPSUM, ETC.

(Investigation of proper quality of lime for different chemical industries; development of standard specifications for lime and gypsum as building materials; laboratory and technical work to determine the qualities of the product; development of methods of testing for plasticity, sand-carrying capacity, soundness, etc.; routine tests of material purchased by the Government; consultation as to the availability of different qualities of material at the markets and for the purpose specified; determination of the value of an addition of hydrated lime to concrete.)

The Use of Hydrated Lime in Concrete.

The use of hydrated lime as one of the ingredients of Portland cement concrete has been rapidly increasing during the past few years. From observations made under working conditions some engineers and contractors make the following claims as to the benefits derived through this practice: Concrete containing hydrated lime requires less water for mixing, is more plastic, separates into gravel and mortar less readily, flows down chutes and into forms more readily, is stronger, denser, and more impermeable to water than concrete not containing hydrated lime.

Since very little experimental work had been done for the purpose of determining the validity of these claims, it was decided to conduct an extensive investigation with this object in view.

Laboratory work in this investigation has been in progress for two years. The following physical properties of concrete have been studied: Compressive strength, bond strength with steel, expansion and contraction with time, amount of water absorption, density of the fresh concrete, modulus of elasticity.

The results have not been completely analyzed on account of the difficulty of choosing the proper basis for comparison. On this account the general tendencies noted in the annual report for 1917 were inaccurate in degree and the statements therein given are to be modified to agree with the present understanding of the effect of different factors upon properties of concrete. At the present time the most comprehensive and logical basis of comparison seems to be a factor known as the water-ratio. This factor, which bears a mathematical relation to compressive strength, is found by dividing the volume of water by the volume of cement used in the concrete. Using this factor as a basis the results show that concrete containing hydrated lime is on the average stronger than concrete without lime, the increase in strength being the more pronounced in air storage specimens and in concretes having the higher water-ratios. Results for the other properties mentioned have not yet been compiled for comparison in this manner.

In regard to the remaining properties, it may, however, be said that the laboratory specimens having all been made with great care did not give so large a degree of difference in properties due to the introduction of hydrated lime as is claimed by contractors and engineers to occur under the conditions of construction work. Moreover, the laboratory results told nothing of the effect upon time of flow down chutes, plasticity, degree of segregation, etc.

For this reason it has been decided to conduct an extensive investigation under working conditions. Preliminary work will be conducted by use of an experimental concrete plant now erected. Following this, observations will be made at various large construction works.

Properties of Hydrated Limes.

The commercial product known as hydrated lime has been upon the market comparatively few years, and although it is manufactured by about 85 companies no complete determinations of its physical and chemical properties had been made. About all that has been known concerning this product is that it has replaced quicklime for a number of the purposes of construction.

During the past three years physical and chemical tests have been made upon 54 samples of hydrated lime collected from all parts of the country. The data affords a fairly complete knowledge of the properties of this product valuable alike to producer and consumer, enabling them to improve the quality and to write accurate specifications.

Plasticity of Hydrated Limes.

Lime manufacturers have become accustomed to use the term plastic lime as meaning a lime producing a paste when slaked and allowed to stand with water, this paste being capable of retaining its water long enough to be spread easily and smoothly upon an absorbent surface such as is provided by the brown coat wall plaster.

Under these conditions the rate of change of plasticity is more important than the absolute plasticity.

The Bureau has designed an instrument now known as the Emley plasticimeter for the purpose of measuring the relative rate of change in the forces acting between a paste and a trowel while the paste is drying out upon an absorbent surface.

By this means lime pastes have been classified into plastic and non-plastic pastes, using the manufacturers' definitions. About 25 hydrated limes from all parts of the country have been tested.

A mathematical definition of plasticity as applied to the use of lime was not obtained and until considerable more work has been done along this line, it will be necessary to use the trade definitions.

Sand-Lime Brick.

The sand-lime brick industry has been seriously hampered during the past year by inability to obtain lime and coal when needed. The principal technical problem at the present time is hence the saving of coal required to produce steam in the steaming process. On account of lack of help the Bureau has not yet been able to attack this problem.

Another important problem is the production of brick of better quality. This involves quality and proportions of the materials, methods of molding, and steaming. One phase of this problem has been attacked, namely, the effect of the size of grain of the sand upon compressive strength of the brick. Three sizes of sands were mixed in 63 different proportions. These sizes were 10 to 40 mesh, 40 to 100 mesh, and 100 to dust. The strongest brick were obtained with mixtures of 30 to 60 per cent 100-to-dust sand, 40 to 70 per cent 10 to 40 mesh sand, and 0 to 20 per cent of 40 to 100 mesh sand. The strongest specimens ($1\frac{1}{2}$ -inch by $2\frac{1}{2}$ -inch cylinders) had a compressive strength of 6,500 pounds per square inch.

Gypsum Products.

No extensive determinations have been made of the properties of gypsum products from mills in this country. There exist no standard specifications for these products.

In order to obtain the necessary knowledge it has been decided to conduct an extensive investigation upon gypsum products from various parts of the country. The preliminary work is now in progress and consists of heating a very pure gypsum to different temperatures and determining such properties as compressive and tensile strength, time of set, optical properties, etc.

The data obtained will afford first-hand knowledge of the quality of the products and enable the Bureau to cooperate with the organizations interested in drawing up standard specifications.

Dolomite as a Refractory.

In many metallurgical furnaces it is necessary to use brick which are chemically of a basic nature. Magnesite brick are so used at the present time but are very high in cost. There are large deposits of dolomite all over the country. If the proper flux could be found to bind and coat dolomite particles so as to prevent rapid hydration of the lime, a dolomite brick could be produced which would replace to a great extent the magnesite brick.

Some work was done along this line but it had to be discontinued on account of lack of help and was not carried out to a practical conclusion. A number of different compositions were used. The most promising composition will be described.

The brick was made of two parts, one of burned material known as grog which formed the skeleton of the brick, the other part of unburned material known as binder. The grog portion was made by burning to a temperature of 1500° C. a mixture of 90 per cent dolomitic hydrated lime and 10 per cent of a special flux, the mixture being ground to pass a 100-mesh sieve. The flux was produced by burning to a temperature of 1400° C. a mixture of equal weights of dolomitic hydrated lime and impure bauxite, ground to pass a 100-mesh sieve. The binder consisted of 85 per cent of the dolomitic hydrated lime and 15 per cent of the flux.

The brick were made by mixing thoroughly 70 per cent of the grog (of 6 to 40 mesh size) with 29 per cent of the binder and 1 per cent of iron oxide, and molding in a power press. The brick was dried in an oven at 110° C. and burned to a temperature of about 1500° C. and Seger cone 20.

The specimens molded with a pressure of 2,500 pounds per square inch appeared to be most satisfactory. Some of the specimens when placed in water resisted hydration for 6 days. Others when left in the open air in the laboratory remained very hard and did not begin to hydrate until they had stood for 6 months. These results would indicate that such a brick placed in a furnace would resist hydration and disintegration for a much longer time.

Hydrated lime was used because a large supply was on hand at the laboratory. For the grog portion and for the flux the hydrated lime could be replaced by ground dolomitic limestone. The binder must be a finely ground material which will not hydrate and cause disintegration in drying and burning. The possibilities for this purpose are hydrated lime, ground dolomitic limestone, ground slag, Portland cement.

The question of costs has not been gone into nor has any attempt been made at a practical application of the method, but the results indicate that the problem can be solved by sufficient experimental work.

III. THE OFFICE.

[Office management; finance and accounts; personnel actions and records; editorial work, printing, publicity; property and stores, including distribution and accounting; mail and files, including test records; scientific library; dispatch, including all forms of transportation and communication; purchasing; stenography, typewriting, and duplicating; and information service.]

The Office Division handles the general business of the Bureau. The aim is to leave the scientific divisions free for the scientific and technical work, although some dovetailing of functions is essential. The office is organized with 10 sections, with representative clerks assigned for the office work for each division. These sections are designated as follows: administrative, finance, personnel, publicity, property and stores, mail and files, library, dispatch, purchases, copying (detailed to division offices), information. Each section has a definite function, and it is the aim that each section shall handle all Bureau business which properly pertains to such function. This policy is equally true of the scientific sections and the sections of the mechanical plant.

The new policy of providing central office overhead allotment from all funds permitted prompt expansion and organization of the office work on a more efficient basis as called for by war conditions. The loss by military demands of nearly all clerks in the 10 sections of the office resulted in hardship and temporary ineffectiveness, which careful reorganization and improved methods have partially remedied. In several sections it is not yet possible to render the most effective service because of the inexperience of new clerks and the highly technical character of the subject matter of the Bureau's work. Rapid progress, however, has been made in bringing the office work to the new standard of efficiency demanded.

It is a pleasure to refer to the unstinted efforts of the entire office force to carry the expanded work under the trying war-time conditions of the past year. The spirit of service has been excellent with no trace of the spirit of mere timeserving. The gratifying work of the past year toward winning the war was made possible by the enthusiastic support of the entire office staff.

FINANCE.

[Records of appropriations and allotments; order and voucher accounts; balances; reimbursements; checking commercial, construction, and travel expense vouchers; pay rolls; test fees; fiscal statistics.]

During the year this section has handled accounts aggregating \$3,414,345.50. In addition to 26 direct appropriations for the Bureau, \$1,395,000 was assigned by the President to the Bureau from the National Security and Defense fund for the purpose of erecting war buildings to provide additional laboratory space needed

to meet the demands of war problems and for specific researches in connection with the war. Other departments of the Government allotted \$218,000 to the Bureau to cover the cost of special cooperative war researches undertaken by the Bureau at their request. The erection of the emergency war buildings on a cost plus basis necessitated the checking by the Accounts Section of the material and labor entering into their construction. The personnel was increased to enable the section to care for the extra financial work involved.

A new card accounting system for handling accounts was devised early in the year and assisted greatly in expediting the accounting work.

A card system is being introduced for pay rolls in connection with the new clerk to be assigned to this work and will place this work on a more efficient basis.

Appropriation Statements.

The following statement shows the amount and object of each appropriation provided for the Bureau for the fiscal year 1918, the disbursement during the year, the amount of unfilled and unpaid orders at the close of the year, and the unexpended balance remaining at the close of business June 30, 1918:

Appropriation.	Total appropriation.	Disbursements.	Liability.	Balance.
Salaries.....	\$348,900.00	\$303,420.27	\$15,952.62	\$29,527.11
Equipment.....	55,000.00	44,138.18	10,639.23	222.59
General expenses.....	35,000.00	27,000.00	6,136.54	1,544.88
Repairs and alterations.....	5,000.00	4,423.19	572.25	4.56
Grounds.....	6,000.00	4,763.11	1,232.13	4.76
High-potential investigation.....	15,000.00	11,180.45	3,810.55	.....
Testing structural materials.....	c 154,130.62	132,403.33	21,727.29	.....
Testing machines.....	30,000.00	22,674.05	7,240.85	85.10
Investigation of fire-resisting properties.....	25,000.00	22,255.75	2,731.68	12.57
Public-utility standards.....	50,000.00	45,904.19	4,095.81	.....
Investigation of railway materials.....	15,000.00	11,495.78	3,504.22	.....
Testing miscellaneous materials.....	20,000.00	19,120.96	879.14	.....
Radio research.....	10,000.00	8,495.41	1,474.33	30.36
Color standardization.....	10,000.00	8,358.54	1,631.43	10.03
Investigation of clay products.....	10,000.00	9,994.53	3.00	2.47
Physical constants.....	5,000.00	4,737.32	251.53	11.15
Standardizing mechanical appliances.....	10,000.00	9,510.66	139.49	349.85
Investigation of optical glass.....	10,000.00	9,002.37	958.90	38.73
Testing railroad scales.....	40,000.00	28,557.71	11,442.29	.....
Additional land.....	25,000.00	.....	.....	25,000.00
Radio laboratory.....	90,000.00	58,096.28	23,569.37	8,334.35
Chemical laboratory.....	200,000.00	197,236.48	319.56	2,443.97
Military research, 1917-1918.....	b 577,176.88	361,512.41	215,664.47	.....
Gage standardization.....	c 226,138.00	141,604.47	84,533.53	.....
Equipping chemical laboratory.....	35,000.00	24,558.89	10,440.84	.27
Repairs, power plant.....	12,000.00	.....	11,870.00	130.00
NATIONAL SECURITY AND DEFENSE.				
Production of optical glass.....	75,000.00	74,539.86	460.14	.....
New building.....	250,000.00	232,552.39	17,447.61	.....
Metallurgical work.....	100,000.00	40,579.65	59,420.35	.....
Production of fabrics.....	35,000.00	326.75	34,673.25	.....
Industrial laboratory.....	925,000.00	257,360.76	415,547.71	252,091.53
Roberts' coke oven.....	5,000.00	1,929.15	2,963.60	77.25
Thermite investigation.....	5,000.00	7.00	699.39	4,293.61
Total.....	3,414,345.50	2,118,067.37	972,063.09	324,215.04

a Includes reimbursement of \$4,130.62.

b Includes reimbursement of \$133,176.93 and allotments from War Department to amount of \$218,000.

c Includes reimbursement of \$1,138.

The following statement shows the condition of the appropriation for the two preceding fiscal years at the close of business June 30, 1918:

FISCAL YEAR 1916.

Appropriation.	Total appropriation.	Disbursement.	Liability.	Balance.
Salaries.....	\$298,780.00	\$283,079.84		\$15,700.16
Equipment.....	50,000.00	48,175.29	\$406.43	1,418.28
General expenses.....	27,000.00	26,645.24	245.55	109.21
Repairs and alterations.....	2,000.00	1,977.78	8.10	14.12
Grounds.....	6,000.00	5,901.11		98.89
High-potential investigation.....	15,000.00	14,908.67	42.25	48.06
Refrigeration constants.....	15,000.00	14,923.23		76.77
Testing structural materials.....	100,000.00	99,437.16	127.53	435.31
Testing machines.....	30,000.00	29,899.16		100.84
Investigation of fire-resisting properties.....	25,000.00	24,888.12	59.00	52.88
Public-utility standards.....	25,000.00	24,800.99		199.01
Railway materials.....	15,000.00	14,514.15	175.51	310.34
Testing miscellaneous materials.....	20,000.00	19,999.96		.04
Current-meter testing tank.....	3,000.00	2,998.34		1.66
Heating system, north laboratory.....	3,000.00	2,520.54		479.46
Radio research.....	\$ 12,308.74	12,141.49		167.25
Testing railroad scales, etc.....	40,000.00	27,751.80	12,248.20	
Total.....	687,088.74	654,562.87	13,313.57	19,212.30

* Includes reimbursement of \$2,303.74.

FISCAL YEAR 1917.

Appropriation.	Total appropriation.	Disbursements.	Liability.	Balance.
Salaries.....	\$311,720.00	\$289,777.80		\$21,942.20
Equipment.....	50,000.00	48,180.70	\$3,819.30	
General expenses.....	28,500.00	27,382.62	878.35	239.03
Repairs and alterations.....	5,000.00	2,612.44	2,153.80	233.76
Grounds.....	6,000.00	5,449.80	497.37	53.33
High-potential investigation.....	15,000.00	14,876.43	10.16	113.45
Refrigeration constants.....	15,000.00	14,942.26	15.00	42.71
Testing structural materials.....	100,000.00	98,634.74	635.84	729.44
Testing machines.....	30,000.00	29,536.44	209.22	254.32
Investigation of fire-resisting properties.....	25,000.00	24,921.59		78.44
Public-utility standards.....	40,000.00	39,627.27	103.92	268.81
Railway materials.....	15,000.00	14,763.43	185.40	51.11
Testing miscellaneous materials.....	20,000.00	19,903.38		96.67
Radio research.....	\$ 15,359.71	10,460.69	4,173.25	725.72
Color standardization.....	10,000.00	8,899.35	992.10	108.57
Clay products.....	10,000.00	9,973.39		26.61
Physical constants.....	5,000.00	4,369.12	153.86	477.02
Standardizing mechanical appliances.....	10,000.00	9,410.64	416.07	173.29
Testing railroad scales, etc.....	40,000.00	35,599.63	4,400.37	
Total.....	751,579.71	707,321.22	18,644.01	25,614.48

* Includes reimbursement for \$5,359.71.

Summary of Tests.

The work of the Bureau involves, among other things, a large amount of testing of standards, measuring instruments, and materials. It involves primarily the investigation of the scientific principles underlying the tests, the studying of existing methods, and the development of new standard tests of determinate accuracy. For each test a reasonable fee is charged, except when made for the National or State Governments.

During the fiscal year 1918 the Bureau made 312,563 tests and inspected 3,727,352 incandescent lamps at various factories for other departments of the Government. Of the total tests, 31,571 were for

the Government and 280,992 for the public. The testing was distributed as follows, according to the nature of the tests: Length measures, 1,064; mass, 1,815; capacity, 504; temperature, 282,094; hydrometry, 2,088; miscellaneous, 30; optical, 2,126; time, 2,064; electrical, 1,910; photometry, 4,874; chemical, 4,589; engineering (miscellaneous), 740; engineering (instruments), 202; structural materials, 3,423; paper and textiles, 4,618; metallurgical, 34; aeronautical instruments, 388. The estimated fees amount to \$102,878.63, of which \$16,626.97 was collected on account of tests for the public. The fees noted for Government tests are included merely for comparison purposes, as no charge is made for tests performed for the National or State Governments.

Number and value of tests completed, fiscal year ending June 30, 1918.

Nature of test.	For Government.		For public.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Length.....	790	\$1,013.35	274	\$420.75	1,064	\$1,434.10
Mass.....	661	606.20	1,154	555.20	1,815	1,161.40
Capacity.....	363	354.00	141	163.70	504	517.70
Optical.....	2,069	3,131.70	57	289.50	2,126	3,421.20
Hydrometry.....	1,440	1,348.70	648	855.10	2,088	2,203.80
Miscellaneous.....	16	36.50	14	25.50	30	62.00
Time.....	2,062	217.70	2	7.00	2,064	224.70
Temperature.....	8,021	1,874.78	274,073	3,014.00	282,094	4,888.78
Electrical.....	1,344	4,611.55	566	2,937.47	1,910	7,549.02
Photometry ^a	4,750	19,174.70	124	255.00	4,874	19,429.70
Chemical ^b	901	4,463.23	3,688	7,232.85	4,589	11,696.08
Physical and mechanical tests:						
Engineering, miscellaneous.....	723	2,335.00	17	18.00	740	2,353.00
Engineering instruments.....	165	886.00	37	198.00	202	1,082.00
Structural materials.....	3,363	28,174.25	60	184.90	3,423	28,359.15
Paper and textiles.....	4,489	15,777.00	129	391.50	4,618	16,168.50
Metallurgical.....	27	197.50	7	72.00	34	269.50
Aeronautical instruments.....	387	2,049.50	1	8.50	388	2,058.00
Total.....	31,571	\$6,251.66	280,992	16,626.97	312,563	102,878.63

^a In addition the Bureau inspected 3,727,352 incandescent lamps at various factories for other department of the Government, the fees for which would amount to \$9,318.38.

^b Of these tests, 2,407, amounting to \$21,722.25, were chemical tests made on structural materials.

Statement showing the number and value of tests made for the Government and the public at the Pittsburgh laboratory of the Bureau of Standards during the fiscal year 1917-1918.

Nature of test.	For Government.		For public.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
CEMENT.						
Physical.....	2,507	\$7,275.00	4	\$18.00	2,531	\$7,293.00
Chemical.....	404	1,424.00			404	1,424.00
CLAY PRODUCTS.^a						
Physical.....	89	570.00	20	71.00	109	641.00
Chemical.....	6	65.00			6	65.00
MISCELLANEOUS.						
Physical.....	95	668.00	54	241.00	149	\$909.00
Chemical.....						

^a In addition, preliminary tests, for which no fee is charged, were made on 52 samples of clay.

PERSONNEL.

[Organization charts of divisions, staff status, individual records of all employees, including military employees; personnel changes, directories, systems of examinations; records of leave, tardiness, delinquency, and efficiency; passes and credential cards, injury and first-aid records and reports, and records of employees who have entered military service.]

Personnel Changes.

During the fiscal year 1917-18 the Bureau staff comprised 278 statutory employees, and about 839 engaged in research and investigations especially authorized by Congress. The statutory positions included 170 scientific positions, 37 office assistants, 46 engaged in the operation of the plant, and 25 in the construction. In addition to the above there were 288 employees detailed from other Government departments or organizations for work in the Bureau, making a grand total of 1,405 employees. There were 2,955 personnel changes during the year, of which 757 were separations from the Bureau; 288 resignations, 568 promotions, and 1,533 appointments. The high labor turnover reflects the war conditions. The enterprise of the members of the personnel section has met the emergency with effectiveness.

Appointments.

	Number.	Total.
Competitive	438	
Excepted	10	
Unclassified	70	
Total permanent		518
Total temporary		1,070
Total appointments		1,588

Separations.

	Number.	Total.
From competitive positions	241	
From excepted positions	17	
From classified positions	30	
Total permanent		288
Total temporary		469
Total separations		757

Promotions and Other Changes.

	Number	Total.
Promotions	586	
Reductions	8	
Miscellaneous changes	21	
Total personnel changes		2,955

Efficiency Methods.

The complexity of the personnel classes, the unusual technical qualifications required, the sudden demands for assistance in emergencies, and the high labor turnover are probably unique in a Federal bureau and have called for efficient planning of methods. New and effective methods were devised and put into operation to facilitate the work, with notable gain in promptness, economy, and efficiency. These include a series of routing slips covering each set routine, as automatic check against omission. Visible indexes were installed, forms and routine were standardized, a daily journal was adopted,

greatly economizing labor in making recommendations. Without these improvements in practically every detail of the work of the personnel section, the work could not have been carried. The results shown in this work during the past year have been gratifying.

PUBLICATION.

[Editorial work, routing of manuscripts and proof documents; archives, publication stock distribution, abstracts of publications.]

The necessity of having the results of the various investigations conducted by the Bureau, available for ready reference throughout the country, makes it imperative that these results be published in pamphlet or book form, in numbers sufficient to provide for wide-spread distribution.

The results of these investigations are published in pamphlet form, and in the following pages are given descriptive lists of these papers. The papers are issued in four separate series: (1) Scientific papers; (2) technologic papers; (3) circulars; and (4) miscellaneous publications. They cover a wide range of subjects in the field of physical measurements and the properties of materials and are issued for general distribution to the scientific, technical, and industrial interests concerned with the subjects treated. Single copies of these publications are sent upon request to scientists specializing in the subjects treated, to those collaborating with the Bureau in its investigations, to organizations exchanging like courtesies with the Bureau, and to depository libraries. Others, however, may purchase them from the Superintendent of Documents. It is assumed that individuals generally are interested in a particular class of work, hence this method of distribution has been adopted in order that each may secure readily the particular information desired.

Publication.

During the past fiscal year the Bureau issued 53 publications, of which 46 were new and 7 were revised editions. In addition, approximately 23 publications were reprinted, owing to the urgent demand for them. The new publications include 15 scientific papers, 16 technical papers, 11 circulars, and 3 numbers of the Bulletin of the Bureau of Standards.

Printing.

During the year 366 printing requisitions other than for publications were prepared. These are for the certificates for tests and the necessary administrative blanks and record books.

Distribution.

Under normal conditions the work of handling requests for publications is completed daily. The efficiency will unquestionably be increased when the adequate space is provided for the work of handling publication stocks. The need for a small stock at the Bureau is imperative, but the congested condition of the room has occasionally resulted in delays. The new plan for handling requests for publications has worked very satisfactorily.

New Publications.

During the fiscal year the following scientific papers were issued: A Method for Testing Current Transformers; Some Electrical Prop-

erties of Silver Sulphide; Axial Aberrations of Lenses; Wave Length Measurements in Spectra from 5600A to 9600A; Specific Heat of Liquid Ammonia; The Latent Heat of Pressure Variation of Liquid Ammonia; Latent Heat of Vaporization of Ammonia; Gas Interferometer Calibration; The Resonance and Ionization Potentials for Electrons in Cadmium Vapor; The Application of Dicyanin to Stellar Spectroscopy; Instruments and Methods of Radiometry, III; Selective Radiometry; Additions to the Formula for the Calculation of Mutual and Self-Inductance; Thermal Expansion of Alpha and Beta Brass; Photo-Electric Sensitivity of Various Substances; Some Characteristics of the Marvin Pyrheliometer.

The following new technological papers were issued: Crystalline Changes in Wrought Iron; Effects of Heat on Celluloid and Similar Materials; Gas Mantle Lighting Conditions in Ten Large Cities in the United States; Determination of Absolute Viscosity by Short Tube Viscosimeters; Investigation of Large Bridge Columns; Properties of Portland Cement Having a High Magnesia Content; Typical Cases of the Deterioration of Muntz Metal by Selective Corrosion; Effect of the Size of Grog in Fire Clay Bodies; Comparative Tests of Porcelain Laboratory Ware; Stabilized Platform Weighing Scale of Novel Design; Comparative Tests of Chemical Glassware; Ground Connections for Electrical Systems; Clay and Porcelain Pots for Optical Glass; The Influence of Quality of Gas and Other Factors Upon the Efficiency of Gas Mantle Lamps; Compressive Strength of Large Brick Piers; Standardization of the Saybolt Universal Viscosimeter.

The following new circulars were issued: Combined Table of Sizes in the Principal Wire Gages; Public Utility Service, Standards of Quality and Safety; Paint and Varnish; Materials for the Household; Rules and Regulations Promulgated under Authority of the Federal Standard Barrel Law; The Scope and Application of the National Electrical Safety Code; Copper; Radio Measurements and Instruments; Safety for the Household.

The Annual Report of the Director of the Bureau of Standards for the Fiscal Year ended June 30, 1917, is the only new miscellaneous publication issued during the year.

PROPERTY AND STORES.

[Property inspection, quantity and quality checking; accession, recording; accountability, charge and release; condemnation and disposal; stores, stock distribution and renewals.]

The office has prepared and issued to the responsible officers of the Bureau a standard stock catalogue listing in detail the items carried in stock in the storeroom. This catalogue contained the principal articles required for use in the offices and laboratories of the Bureau. The central stock room purchased and stored approximately \$43,000 worth of material. This involved the handling of the approximately 19,200 items for the central storeroom. In addition, approximately \$37,000 worth of standard stock was distributed to the laboratories, including 19,800 stores requisition and 104,000 items issued. During the last part of the year the work of the storeroom increased by about 40 per cent.

Equipment Records.

The work of accession and recording of inventoried equipment comprises the writing of 28,000 cards and 19,700 pieces of equipment. The growth of this work has in the past 6 months increased 50 per cent.

Progress.

A perpetual inventory method showing at a glance all items carried in stock and the quantities on hand has been initiated in the storeroom. Adequate housing for the overflow stock has been fitted up, but the rapid growth in this section will necessitate permanent provision of larger space.

PURCHASE.

[Trade catalogues and dealers' lists; requisition inspection; preparation of orders, bids and orders, order follow-up; purchase and transportation checking.]

The activities of this section increased 100 per cent during the past year, necessitating the reorganization of the office and the separation of this section from the storeroom and finance sections.

The rapid expansion of the Bureau's work during the year caused by the war resulted in a very large increase in the number of orders placed, 8,069 orders being the total number, 5,440 largely for technical materials and apparatus.

The Purchase Section maintains a file of scientific and industrial catalogues for consultation. The variety of technical equipment and supplies required calls for investigation which takes a considerable part of the time of those concerned. Records are kept of the purchases and quotations in such form that they may be readily consulted in future cases.

MAIL AND FILES.

[Handling of correspondence, including business and technical communications of all kinds; the accession, distribution, and filing of such papers; test records.]

No section in the Bureau has suffered a more complete loss of experienced and skilled assistants than the section of mail and files. The loss of the entire staff of 6 men, with the experience which they had acquired in their years of service, could not be made up promptly. The war caused a rapid increase in the work and it became necessary to route military mail to secure promptness on urgent cases and confidential handling on other cases, and systematic follow-up for all military matters. A new system of record and follow-up was devised and put into effect in the director's office, with marked increase in the efficiency of such work. The volume of correspondence increased very greatly and a new classification is now being installed.

LIBRARY.

[Maintenance of scientific and technical library; bibliography; accessioning new books; loan and accountability records; assistance to technical staff, and rebinding.]

The Bureau maintains a scientific library, containing 16,339 accessioned volumes. Three hundred and forty-two scientific and technical periodicals are currently received. This is an increase of 45 over the previous year. The number does not include 96 different journals which fail to reach the Bureau on account of the war. Of the latter, 74 are German journals.

Important Accessions.

The library has been fortunate in being able to secure a large number of missing numbers and volumes of important journals and to complete a number of the more important sets. This was not accomplished without the most careful scrutiny of the catalogues of second-hand works, published in America and Europe.

Equipment and Space.

While the library is in congested quarters, the equipment is modern and effective for its purpose. Additional space, however, is urgently called for in order that the centralization demanded by efficiency may be completed.

DISPATCH.

[Transportation and communication of all kinds, comprising telephone and telegraph service, express, freight and mail shipments, drayage, and messenger service.]

The work of this section has been somewhat divided, owing to the rapid growth of the Bureau and the failure thus far to fully centralize the dispatch service. Plans have been perfected for the consolidation, and it is expected that this will be accomplished in the very near future. The work of the section has expanded very greatly requiring now the service of five trucks and three automobiles. The fact that the work of the Bureau is distributed in approximately 18 buildings and that the Bureau is located at a distance from the center of the city, has made the work of dispatch more than usually difficult, especially under war-time conditions.

COPYING SECTION.

[Editing rough drafts of letters, reports, and manuscripts; stenography; typewriting; and mimeography.]

For convenience, and at some sacrifice of efficiency, the staff in this section is detailed to the several divisions of the Bureau. The copying of manuscripts of technical reports of researches and tests, and the work of technical correspondence, has grown very rapidly during the year. The rapid expansion of the entire Bureau and the urgency of the utmost dispatch of obtaining and publishing results has necessitated a very large addition to the staff of clerks engaged in the general work of stenography and typewriting. The sacrifice in efficiency is believed to be justified at present, since centralization would require commodious and suitable quarters. Attention is called to the urgent need for an office building of the modern type, designed and constructed throughout for the specialized work of the various sections of the office.

INFORMATION SECTION.

[Requesting, receiving, distributing, and filing of scientific and technical information of a military bearing; maintenance of a progress-of-work chart and follow-up system covering all tests, subjects of inquiry, investigations, and researches in progress for the military services.]

Progress-of-Work Records.

Some time after the entry of the United States into the war it became apparent that in order efficiently to care for the large amount

of military work regularly coming into the Bureau, it would be necessary to inaugurate some form of central progress-of-work record. Accordingly, a very efficient yet simple method was developed by which all the military tests, investigations, and inquiries for information are recorded at the time of their receipt. Thereafter, by a very simple notation, entries are made indicating the progress of the work up to the stage of the completion and mailing of the final report.

The system used, which is a novel one specially developed for the work, was described in the Journal of the Franklin Institute. The operation of the system is so carried out as to interpose no delay in the progress of an incoming inquiry or request. The aggregate of the entries currently carried on the chart is now very large in number and the record obtained, which is continually up to date, affords at all times a concise, clear-cut representation of the Bureau's activities carried on for the military services in all lines of testing, investigation, research, and compilation of technical information in answer to inquiries. Moreover, the chart discloses all cases in which abnormal delays are occurring in the carrying out of work and by the collateral employment of a follow-up or reminder system, enables the necessary corrective measures to be taken to eliminate serious and preventable causes of delay. The use of this system has already been efficacious in detecting and indicating means for correction of conditions likely to interfere with the promptest possible handling of military work.

Distribution of Military Information.

On account of the rapid changes occurring in modern warfare, with its tremendous employment of scientific and technologic resources, methods of combat and communication in use to-day are likely to be fundamentally improved or completely replaced in a very short time by a single new invention or scientific discovery. Therefore, the rapid circulation of accurate and dependable technical information to all workers in scientific and technologic fields having military application is of paramount importance. On this account and to care for the considerable mass of technical information covering every conceivable branch of physical and chemical science which the Bureau receives from the various offices of the War and Navy Departments and from research agencies of civilian character engaged in military problems here and abroad, an Information Section has been inaugurated, in which all manner of confidential information of the types just described is received. Notices of receipt and abstracts of such information are forwarded to those technical sections of the Bureau concerned with the particular subject of each document and other necessary matters relating to the distribution and dispatch of such reports are cared for.

Respectfully,

S. W. STRATTON, *Director.*

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
DIRECTOR OF THE CENSUS

441

REPORT

OF THE

DIRECTOR OF THE CENSUS.

DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
Washington, September 16, 1918.

SIR: There is submitted herewith the following report upon the operations of the Bureau of the Census during the fiscal year ended June 30, 1918, and the work now in progress:

INTRODUCTION.

During the fiscal year the Bureau of the Census completed the compilation and preparation for publication of the final detailed reports of the last quinquennial census of manufactures; carried on its decennial canvasses of water transportation and shipbuilding and of religious bodies, its quinquennial canvass of electrical industries, and its special canvass of marriage and divorce; prepared and published the Official Register of the United States; conducted its regular annual inquiries relating to births, deaths, States, and municipalities; collected and published quarterly statistics of stocks of leaf tobacco; made semimonthly and monthly collections and publications of statistics on cotton, cotton seed, and cottonseed products; completed the preparation of reports on Negroes, deaf-mutes, and prisoners and juvenile delinquents, and of a statistical directory of State institutions for the dependent, defective, and delinquent classes; took a special census of the Virgin Islands; gathered data as to receipts of fresh fish in New York City; inaugurated the publication of weekly mortality reports for certain large cities; performed a considerable amount of war work for other Government establishments; carried on its preparations for the Fourteenth Decennial Census; and complied with numerous requests for information contained in its records.

The work done during the fiscal year and since its close along the various lines above specified is described in the sections headed "Current and completed work on statutory inquiries," "War work," and "Special and miscellaneous lines of work," which follow.

CURRENT AND COMPLETED WORK ON STATUTORY INQUIRIES.

CENSUS OF MANUFACTURES.

The compilation and preparation for publication of the reports of the last quinquennial census of manufactures, taken as of December 31, 1914, were, in the main, completed early in the fiscal year, al-

though considerable detail work in connection with the checking and verifying of proof remained to be done later in the year.

In the case of many of the bulletins which present the final reports of the census of manufactures, copy was sent to the printer at relatively earlier dates than those at which copy for the corresponding bulletins was sent to the printer at the preceding census.

CENSUS OF TRANSPORTATION BY WATER.

Under the act creating the permanent Census Bureau a census of water transportation is taken at decennial intervals. The last inquiry of this character was made as of December 31, 1916. The field work was begun in March, 1917, and was completed in October of the same year. Through cooperation with the Bureau of Foreign and Domestic Commerce, the Customs Service, the Post Office Department, and the American Steamship Association, it was possible to facilitate greatly the work on this inquiry and to keep down its expense. The effort to collect a large proportion of the data by mail, and in some cases by telegraph, was successful, and about 50 per cent of the owners or operators of craft covered by the census were canvassed in this manner before the field force left the office. Although this method necessitated a great amount of correspondence, it materially reduced the expense of the field work and shortened the time required for taking the census.

This census covered also the operations of fishing vessels, which were not canvassed at the last preceding similar inquiry.

During the progress of the field work and after its completion the compilation of the data gathered was carried on as rapidly as possible, and a preliminary statement comprising two tables with descriptive text was prepared in the latter part of January, 1918, and released for the use of afternoon papers on February 6.

The tables and text for the final report have been completed and will be sent to the printer at an early date. This report will cover the operations of 37,894 vessels, classed as steam, sail, and unrigged craft, and will give detailed statistics as to tonnage, value, ownership, employees, wages, amount of business done, etc., for the various classes of craft.

CENSUS OF SHIPBUILDING.

This census, which was taken in conjunction with the water-transportation inquiry and related to the same date—namely, December 31, 1916—covered the operations of 1,377 shipbuilding establishments during the calendar year. It was possible to obtain a large proportion of the reports by correspondence, and the cost of the canvass was thus reduced to a minimum. Statistics for the shipbuilding industry for the year 1914, which were secured at the last census of manufactures, were also included in the report.

For military reasons this report has not been published, but the statistics compiled have enabled the Census Bureau to furnish valuable information of a confidential nature to various war boards.

CENSUS OF ELECTRICAL INDUSTRIES.

This census, which, under the act creating the permanent Census Bureau, has been taken quinquennially since 1902, covers central

electric light and power stations, street and electric railways, telephones and telegraphs, and municipal electric fire-alarm and police-patrol signaling systems. The current inquiry is being made as of December 31, 1917.

By reference to the various records available, supplemented by correspondence with some 14,000 postmasters throughout the country, with State telephone associations, and with public-service commissions, a card index of establishments engaged in electrical industries was prepared. In formulating the schedules used, criticisms and suggestions were requested and obtained from the Interstate Commerce Commission, the American Telephone & Telegraph Co., the independent telephone companies, the American Electric Railway Association, the American Railway Accountants' Association, and the National Electric Light Association, and a number of conferences were held with representatives of these organizations. All the organizations named have given their hearty cooperation and have rendered valuable assistance to the Bureau in the revision of the schedules and the preparation of the reports.

In accordance with the general practice of the Bureau, the data have been collected so far as possible through correspondence. The field canvass, which is being made by employees detailed from the office, was begun on April 9 in Omaha, Nebr., and will be practically completed some time during October.

The necessary detail work of checking the schedules received with the card index, examination, criticism, returning for correction when necessary, editing, and preparation for tabulation has been carried on as rapidly as possible, and the compilation of the reports is now under way. These reports will present information as to number of establishments, character of ownership, traffic, equipment, expenses, employees, salaries and wages, finances, etc.

RELIGIOUS BODIES.

Under the law establishing the permanent Census Bureau the census of religious bodies is taken at decennial intervals. The collection of the data at the last inquiry, which was made as of date December 31, 1916, was substantially completed in March, 1918, except for certain special statistics in regard to ministers, the collection of which was not finished until July, 1918. The work was done almost entirely through correspondence, which method made possible a great saving in expense, but necessarily resulted in somewhat greater delay in obtaining the desired data from certain churches and ministers who did not respond readily or promptly to the Bureau's requests for information.

The tabulation of the data has been in progress for some time. A preliminary report in the form of a press announcement was issued on May 2, 1918, which showed, by principal denominations, the numbers of church organizations, members, ministers, Sunday schools, Sunday-school officers and teachers, and Sunday-school scholars. The final report will present, for each religious denomination, detailed statistics in regard to the subjects dealt with in the press announcement, and in addition will show the value of church property, salaries of ministers, and various other items of information.

The work on this inquiry has been delayed somewhat by the pressure of war work, and in particular by the employment of a considerable force upon the classification of occupations of registrants for the Provost Marshal General.

VITAL STATISTICS.

Death statistics.—Since its organization on a permanent basis in 1902 the Bureau of the Census has been compiling annual reports on mortality, based on data collected from States and cities having adequate death-registration systems. The "registration area" comprising these States and cities, which in 1900 contained only 40.5 per cent of the population of the country, has grown from year to year until at present it embraces 28 States, the Territory of Hawaii, the District of Columbia, and 42 cities in nonregistration States, and contains approximately 73 per cent of the population. The States now included are the six New England States and New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Ohio, Michigan, Indiana, Kentucky, Tennessee, Wisconsin, Minnesota, Missouri, Kansas, Montana, Colorado, Utah, Washington, Oregon, and California. The most recent additions were the State of Tennessee and the Territory of Hawaii, admitted for 1917, and the State of Oregon, admitted for 1918. The inclusion of Hawaii extended for the first time beyond the limits of continental United States the area for which the Bureau annually collects and publishes mortality statistics. The admission of a State, Territory, or city is made only after a test, the results of which indicate that the deaths occurring are recorded properly under State law or municipal ordinance, and that the registration is at least 90 per cent complete.

A test of the completeness of the death registration in Illinois (outside certain cities whose registration is already accepted by the Census Bureau) was begun in the latter part of August, and if the result is satisfactory, as is expected, the registration area will be further extended and will contain about 76 per cent of the total population of the United States.

The annual mortality report for the calendar year 1916 was completed and the revised proof was returned to the printer during the fiscal year 1918. This report shows, for the registration area as a whole, for States, and for cities of 10,000 or over, the number of deaths, exclusive of stillbirths, by month of occurrence, age, sex, color, nativity and parent nativity, and cause. Death rates per 1,000 population from all causes combined and per 100,000 population from individual causes are also given.

In order that the more important of the mortality statistics for 1917 may be placed in the hands of the public at the earliest possible date, a bulletin presenting certain of the basic tables which will later be included, with very little text discussion, in the final report will be prepared and sent to the printer by the close of the calendar year 1918.

Birth statistics.—Beginning with 1915, the Census Bureau has been collecting annually birth statistics from a registration area composed of those States (and the District of Columbia) having adequate birth-registration systems. This area, which in 1915 comprised only

the six New England States and New York, Pennsylvania, Michigan, Minnesota, and the District of Columbia, with a total population estimated at about 31 per cent of the aggregate for the United States, has grown very rapidly, until at present it embraces the States just named, together with Maryland, Virginia, North Carolina, Ohio, Kentucky, Indiana, Wisconsin, Kansas, Utah, and Washington, making 20 States in all, in addition to the District of Columbia, with a total population representing about 53 per cent of the aggregate for the United States. The completeness of the birth registration in Illinois is now being tested, and if that State measures up to the standard, the total population of the area will be increased to about 59 per cent of the aggregate for the country.

The birth reports show, for the registration area and its subdivisions, the number of births, by sex, month of occurrence, color, and parent nativity of white children; the numbers of births and deaths, with excess of births over deaths and number of births per 100 deaths; the number of births of white children, by country of birth of father and mother; and the number of deaths (exclusive of stillbirths) in the birth-registration area, from important causes, for 12 subdivisions of the first year of life.

The birth-statistics report for 1916 was completed and copy sent to the printer during the fiscal year 1918, and the report for 1917 will be ready for the printer by the close of the calendar year 1918.

International list of causes of death.—During the fiscal year a reprint was made of the Manual of the International List of Causes of Death. The Physicians' Pocket Reference to the International List of Causes of Death was also reprinted, and as soon as the American Medical Directory for 1918 is published a copy of the booklet will be sent to every physician in the United States.

Weekly health index.—On October 6, 1917, the Bureau of the Census inaugurated the publication of a "Weekly Health Index," which gives mortality reports from about 50 of the largest cities in the United States. For each city are given the total number of deaths reported for the week (stillbirths excluded), the death rate, the number of deaths under 1 year of age, and the proportion which infant deaths represent of total deaths. Each Weekly Health Index is issued within 72 hours after the close of the week to which it relates.

FINANCIAL STATISTICS OF CITIES.

Reports on municipal finance have been published annually by the Bureau of the Census since its organization on a permanent basis in 1902. The compilation of the report presenting financial statistics of cities having more than 30,000 inhabitants, for the fiscal year 1917, was completed and copy was sent to the printer in January, 1918, or within less than seven months from the close of the fiscal period covered. The report, which is printed in the form of a 373-page quarto volume, presents statistics in regard to the following subjects, the figures for each city relating to its latest fiscal year ended prior to July 1, 1917: (1) Total and per capita receipts from the various sources of revenue; (2) total and per capita payments for expenses, interest, and outlays, the payments for expenses and outlays being given in detail; (3) total value of city properties; (4) total and per

capita indebtedness; and (5) estimated true value and assessed valuation of property, tax levies, rates, and methods of assessment. In the introduction to the volume are given definitions of terms employed in municipal accounting.

In addition to the classes of statistics just specified, the report gives the numbers, terms of office, method of election, and annual salaries of certain city officials; form of government (mayor and council or commission); if under commission form, date when commission plan became operative, and departments over which each commissioner presides; and a historical sketch of the modern movement toward the commission form of government in American cities.

The field work on the inquiry now in progress, which covers the fiscal year 1918, will be finished by December of this year, and copy for the report will be in the hands of the printer early in 1919.

The statistics on municipal finance are especially useful at the present time, when, because of war conditions and the resultant necessity for retrenchment wherever possible, American cities are obliged to economize to the greatest practicable extent in the conduct of their governmental activities. Any municipal official, member of a civic body, or other citizen desiring to ascertain whether the financial affairs of his city are being conducted efficiently and economically can obtain much useful information by comparing his city with others in regard to such matters as its various classes of revenues and expenditures; its property valuation, tax rates and levies, and method of assessment; and its indebtedness and value of public properties.

GENERAL STATISTICS OF CITIES.

Since the creation of the permanent Census Bureau, in 1902, reports on various phases of municipal governmental activities, other than financial, have been published by the Bureau, at first biennially and later annually. The reports on this group of subjects for the fiscal year 1917 are two in number, namely, "Specified sources of municipal revenue" and "Statistics of fire departments."

The first-named report—copy for which was sent to the printer in December, 1917—presents, for the 219 cities estimated to have more than 30,000 inhabitants, data in regard to certain methods of raising revenues, namely, deriving them from business taxes collected without the issue of licenses, as on gross earnings of insurance companies; from business taxes, other than on the liquor traffic, collected through the issue of licenses; from other license taxes; from special assessments for public improvements, as street paving, sidewalks, and sewer construction; and from assessments for other purposes, as for street cleaning and sprinkling.

The information contained in this report is made available at a most opportune time, when the cities are readjusting their revenue systems so as to distribute the burden of taxation more equitably in regard to both their own needs and the unusual requirements of the National Government because of the state of war now existing. The report is also of special interest to cities which have recently outlawed the liquor traffic or are about to do so, and which, therefore, will be obliged to take under consideration other available methods of raising revenue.

The report giving statistics of fire departments of cities estimated to have more than 30,000 inhabitants in the fiscal year 1917 was sent to the printer in January, 1918. This report presents, in detail, data pertaining to organization, equipment, grades and salaries, special training of firemen, appointments, promotions, pension systems, and other statistics considered to be of interest and value by authorities on this subject.

A report on municipal markets, covering the fiscal year 1918, is now in process of preparation. This report will show the extent of municipal activity in providing market facilities and the use made of these facilities by the citizens. A report of this character should be particularly helpful at this time, when saving in food cost is a necessity for most people and food conservation is a patriotic duty for all. The field work on this inquiry will be completed during the coming December, and copy for the report will go to the printer early in 1919.

FINANCIAL STATISTICS OF STATES.

The report presenting financial statistics for the 48 States of the Union, covering in each case the latest fiscal year terminating prior to July 1, 1917, was completed in April, 1918, and sent to the printer shortly thereafter. This report, which is the third of the series of which it forms a part, is similar in scope to the municipal-finance reports, the general classifications being the same, and the only changes being those made for the purpose of showing data in regard to functions exercised by State governments that are not generally exercised by municipal governments. As pointed out in my former annual report, these reports have proven useful to State officials, and the annual visits of the Bureau's agents to collect the statistics will be influential in bringing about the installation of proper accounting systems, as was the case with the cities of over 30,000.

The report for 1918 will be completed early in 1919.

COTTON AND COTTON SEED.

During the fiscal year ended June 30, 1918, the Bureau of the Census conducted its regular inquiries in regard to cotton and cotton seed. The reports issued comprised 10 relating to cotton ginned to specified dates during the ginning season; 12, published monthly during the year, relating to cotton consumed, imported, exported, and on hand and to active consuming cotton spindles; 12, published monthly during the year, relating to cotton seed received, crushed, and on hand and to cottonseed products manufactured, shipped out, and on hand; an annual bulletin on cotton production and distribution for the season of 1916-17; and a pamphlet giving complete statistics of cotton ginned from the crop of 1917. This pamphlet was distributed in time to be of use in making comparisons between the crop of 1918 and those of previous years.

The periodical reports on cotton ginned, the monthly reports on cotton consumed, etc., and the monthly reports on cotton seed and cottonseed products are issued in the form of post cards, which are mailed to a large number of growers, ginners, manufacturers, dealers, and others interested in the cotton and cottonseed industries. The

annual bulletin presents in detailed form the statistical material contained in the post-card reports for the year preceding, together with data relative to cotton production and consumption in foreign countries and other information concerning the cotton and cottonseed products industries.

STOCKS OF LEAF TOBACCO.

During the fiscal year there were published four reports on leaf tobacco held by certain classes of manufacturers and dealers coming within the scope of the act of Congress approved April 30, 1912. These reports presented data as to leaf tobacco held on July 1 and October 1, 1917, and January 1 and April 1, 1918.

Bulletin 136, entitled "Statistics of Leaf Tobacco," which was prepared and distributed during the fiscal year, presents in comparable form the data collected at the several tobacco inquiries which have been made since the inauguration of the work in October, 1912. In addition to the statistics of leaf tobacco held, the bulletin contains data regarding the production, consumption, imports, and exports of tobacco; the prices obtained for the staple by the growers; the quantities of the several classes of products manufactured therefrom; and the revenue from tobacco collected by the Government of the United States. Statistics are also shown for the world's production of tobacco and the international trade in unmanufactured tobacco. This bulletin, the first of its kind ever issued by the Government, was designed for the purpose of assembling the statistics for the various phases of the tobacco industry published by the several Government bureaus and presenting them in convenient form for ready reference.

WORK PERTAINING TO SPECIAL CLASSES OF THE POPULATION.

The work on the reports specified below has been hampered greatly because of the necessity of employing the Census Bureau's force—which has not been large enough to meet all the demands made upon it—on other work believed to be of more immediate importance. The salient statistical facts derived from the inquiries, however, were first published in the form of bulletins; and the complete reports, which present these facts in greater detail, with text discussions and analyses, have been recently issued.

Deaf-mutes.—The report on deaf-mutes was completed during the fiscal year, and has since been published. This report was submitted in proof to various specialists and others interested in the subject and received high commendation from them.

Negroes.—The preparation of the report on Negroes was completed during the fiscal year, and it will be published in the near future. This report is a compilation in one volume of all the census statistics pertaining to the Negro race which have been collected during the entire period from 1790 to the present time. It includes, in addition to data from the decennial reports, annual mortality statistics relating to Negroes for the years 1900 to 1915. This special report is of unusual statistical value in itself, and in addition contains a great deal of matter which will be useful for comparative purposes in compiling the reports of the next decennial census.

Prisoners and juvenile delinquents.—The final work on this report was done before the close of the fiscal year, and it will soon be published. As in the case of the other reports dealing with special classes, it presents, in addition to the main statistical tables, numerous minor tables bearing on particular phases of the subject, together with detailed text discussion and analysis.

OFFICIAL REGISTER.

Under the present law the Census Bureau compiles biennially the Official Register of the United States, which consists mainly of a directory of Federal employees, showing name, designation, compensation, branch of service in which employed, etc. The issue for July 1, 1917, was prepared during the first half of the fiscal year.

I renew the recommendations for changes in the scope of the Official Register which appear on page 39 of my annual report for the fiscal year 1917 and which were also contained in the reports for the four preceding years. The Official Register in its present form, even under normal conditions, is of relatively slight value; and at a time like the present, when the energies of every member of the Census force are needed on important work—including war work along various lines, and including also the great task of making proper preparations for the Fourteenth Census—it is especially unfortunate that the Bureau should be under the necessity of employing a portion of its force in the compilation of a publication of so little and ephemeral value as the Official Register.

I therefore urge the enactment into law of the bill (H. R. 2354) now pending in the House of Representatives, which embodies the desired changes in the scope of the Official Register. If the enactment of this legislation is not considered advisable, I strongly urge that legislation be enacted directing the suspension of the Register until the conclusion of the war, or until further authorized by Congress.

WAR WORK.

WORK DONE BY THE BUREAU FOR OTHER GOVERNMENT ESTABLISHMENTS.

During the fiscal year the Bureau of the Census performed numerous pieces of work pertaining to the war, some of which required the services of a considerable number of employees, for the War Department and for other Federal departments and establishments. The more important of these pieces of work are set forth below.

Census of materials and commodities for use of war agencies.—In February, 1918, the Secretary of Commerce, at the suggestion of the Director of the Census, offered to utilize, in the performance of the statistical work of the various war agencies, the services of as many as 100 Census employees for 6 months. This offer was accepted by a number of the war agencies—the War Trade Board, the War Industries Board, the Shipping Board, the Food Administration, the Council of National Defense, and the Commercial Economy Board—and on April 8 the work was given specific authorization by the President, who, in addition, wrote the Secretary of Commerce expressing his thorough approval of the project.

The war agencies were particularly desirous to have statistics compiled showing the consumption and stocks on hand of certain raw materials used in war industries, and also the production and stocks on hand of certain of the commodities made therefrom. The materials and products for which the need of information was most urgent were the following:

Iron and steel.

Wool machinery and woolen manufactures.

Kapok fiber, jute, and silk.

Leather stocks, boots, shoes, and manufactured leather goods.

Antimony.

Graphite crucibles.

Questionnaires or schedules covering these commodities were prepared, and at the close of business on August 31, 119,831 had been mailed. Preliminary reports on wool machinery and production therefrom, kapok fiber, jute, leather stocks, and graphite crucibles, have already been compiled and transmitted to the war agencies.

The compilation of data on the other commodities listed above is progressing as rapidly as the returns are received, and considerable work has been done in the study of still others for which statistics are desired.

In connection with the preparations for this inquiry, a survey of the existing sources of statistics of supply, production, and consumption of materials and commodities was made for the purpose of ascertaining what data were being collected by other bureaus or Government agencies, the purpose being to prevent or eliminate any duplication of statistical work. As was anticipated, more or less such duplication was discovered and eliminated. This survey will be continued with a somewhat broader scope during the period of the war by the statistical clearing house organized in connection with the War Industries Board.

I take this occasion to express my opinion that the usefulness of the Bureau of the Census would be materially enhanced if the scope of its work were extended by law so as to make the Bureau a permanent clearing house for all the statistical information issued by the executive branch of the Federal Government. This could be done by having all the executive departments and independent Government establishments submit reports, monthly or quarterly, to the Bureau of the Census describing all statistical data compiled or published during such period. This would enable the Bureau to detect any duplication or overlapping existing in the statistical work of the Government and recommend its elimination. It would also make Federal statistics more easily available to the public and to persons engaged in research work, and would result in bringing about a material saving in expense.

Census of commercial greenhouses.—For the use of the Priorities Division of the War Industries Board, the Bureau gathered data pertaining to commercial greenhouses covering, for the year ended June 30, 1918, area; value of products; fuel, fertilizers, insecticides, and fungicides used; and number of males 18 years of age and over continuously employed.

Censuses of nitric acid and of acids and materials used in the manufacture of explosives.—In September, 1917, in accordance with the

request of the Committee on Chemicals of the Council of National Defense, the Acting Secretary of Commerce authorized the Director of the Census to take a census of the production and capacity of plants engaged in the manufacture of nitric acid; also a census of the production and capacity of establishments manufacturing sulphuric acid and materials used in making acids and explosives, and the distribution of these commodities, which include cannon powder, mobile artillery powder, small-arms powder, trinitrotoluol, picric acid, ammonium nitrate, and military guncotton. The necessary blanks, together with the lists of manufacturers to whom they were to be sent, were prepared in collaboration with the Committee on Chemicals. The blanks were addressed and mailed and the reports received, checked, and acknowledged by the Bureau of the Census, which then transmitted them to the Committee on Chemicals for tabulation. The portion of the work assigned to the Bureau of the Census was completed in November, 1917.

Production of dental gold.—At the request of the Federal Reserve Board, in connection with its war activities, the Secretary of Commerce authorized the Bureau of the Census to make a canvass of the production of dental gold. Accordingly a questionnaire calling for the desired information covering the calendar year 1917 was prepared and mailed to manufacturers of dental goods. Returns were received from and tabulated for 64 establishments, and statements were prepared for the Federal Reserve Board showing the production of dental gold by States, and the amounts and values representing the gross domestic consumption and exportation of this commodity.

Estimates of registrants for Provost Marshal General.—In May, 1917, immediately following the passage of the selective-service law, the Bureau of the Census published an estimate of 10,077,700 as the total number of men 21 to 30 years of age, both inclusive, in the United States. The actual registration on June 5, 1917, was 9,691,344; but if to this number were added approximately 400,000, representing men within the specified ages who were already in the military and naval services and therefore not required to register, the total would be brought very close, indeed, to the estimate.

On June 12, 1918, the Bureau, at the request of the Provost Marshal General, made an estimate of the number of men who had become 21 years of age during the year ended June 5, 1918. This estimate showed a total of 1,011,589 for the entire country. The actual number of registrants on June 5, 1918, plus the number of enlistments of men aged 21, amounted to 953,453; but the greater part of the difference of 58,136 between this number and the estimate is accounted for by a decrease of 45,098 in the number of aliens subject to registration.

On July 30, 1918, at the request of the Provost Marshal General, the Bureau estimated the number of men aged 18 to 20 years, inclusive, and 32 to 45 years, inclusive, in the United States on July 1, 1918. The total given by this estimate was 13,194,408. The registration on September 12 was 12,870,000, to which number should be added approximately 400,000, representing men within the ages specified who were already in the service. The total thus obtained, 13,270,000, differed from the estimate by only a little more than one-half of 1 per cent, thus again confirming the substantial accuracy of the Bureau's figures.

Allocating enlistments for the Office of the Provost Marshal General.—The 117,974 men who enlisted in the Regular Army from April 2 to June 30, 1917, inclusive, represented a portion of the credits to be applied to the gross quotas of the States, the counties, and the cities of 30,000 population and over in the apportionment of the first draft. At the request of the Provost Marshal General these enlistments were allocated by the Bureau of the Census. In addition, the enlistments in the Navy, the Naval Reserve, the National Naval Volunteers, and the Marine Corps from April 2, 1917, to June 30, 1918, which numbered 293,788, were similarly allocated in anticipation of the credit of these volunteer enlistments to the quotas of the various States, as proposed in the bill providing for the second draft, as it passed the House. This provision, however, was rejected by the Senate and was stricken out in conference.

Classification of occupations of registrants for Provost Marshal General's Office.—This work was undertaken at the request of the Provost Marshal General, dated December 21, 1917, that a detachment of skilled workers from the Census Bureau be sent to the War Department to train the clerks who were to be assigned to the preparation of an industrial index of the registrants under the selective-service act. The preparation of this index consisted in the classification, according to occupational skill or experience shown, of cards prepared by the local registration boards from questionnaires filled by registrants. The Census scheme of classification of occupations was used.

Preparatory work was done during the latter part of December and in January, but it was not until the middle of February that the number of cards received at the War Department became sufficiently large to make it feasible to begin the actual work of classification. From that time until July 1, 1918, a period of four and one-half months, a force of experienced Census employees, numbering about 30 during the greater part of the period, was employed, under the direction of the chief statistician for population, in supervising and guiding the work of about 250 clerks employed by the War Department.

The total number of cards received to the end of June, 1918, and classified under the direction of the expert Census force was 8,147,034. In the classification and verification of these cards it was necessary to handle most of them two or three times, so that the total number of handlings of cards, for all purposes, amounted to 23,707,872.

This work in some respects was most complex and could not have been successfully handled by inexperienced employees. The skill and energy displayed by the Census force were greatly appreciated by the Provost Marshal General, who, in a letter dated June 26, 1918, to the Director of the Census, paid a high tribute to the value of the service rendered in the prosecution of this important piece of war work.

Determination of ages of registrants.—Much work was done during the fiscal year in connection with the furnishing of transcripts of ages of persons who failed to register under the selective-service law but were believed to be within the specified age limits. These transcripts were supplied to the Department of Justice, to local registration boards, and to the individuals concerned. Because of the fact that in many instances the men in question had been arrested and

were in jail awaiting the settlement of their cases, it was highly important that this work be done with the utmost promptness. The Bureau has been advised by county officials that as soon as it became generally known that they had access to Census information in regard to ages many men came in voluntarily and registered. The recent extension of the draft ages will cause a great increase in this class of the work.

Liberty Loan work.—In connection with the Liberty Loans made during the fiscal year the Census Bureau rendered aid to the Treasury Department by sending out Liberty Loan literature to various mailing lists.

Work for the United States Fuel Administration.—For the Fuel Administration the Bureau compiled information, based on the data obtained at the last census of manufactures, showing the kinds and quantities of coal consumed by establishments using 100 tons or more per annum, and whether such establishments generated electricity for power. It also supplied the Fuel Administration with a list of cotton ginneries in the State of Georgia, and prepared index cards for use in the compilation of a list of names and addresses of establishments engaged in the manufacture of brick and tile, cement, glass, pottery, lime, and sand-lime brick.

Work for Railroad Wage Commission.—During the months of February and March, 1918, the Census Bureau prepared a large number of tables for the use of the Railroad Wage Commission in connection with the adjustment of the wages of railroad employees by the Federal Railroad Administration.

Miscellaneous war work.—In addition to that above specified, the Census Bureau has performed war work for the American National Red Cross, the Department of Justice, the Council of National Defense, the Housing Committee, the United States Shipping Board, the Emergency Fleet Corporation, the Medical Corps of the War Department, the Federal Trade Commission, the Federal Reserve Board, the United States Geological Survey, the Joint Information Board on Minerals and Derivatives, the Tanners' Council of the United States of America, the National Committee on Prisons and Prison Labor (through the Bureau of Foreign and Domestic Commerce), the Bureau of Education, the War Industries Board, the United States Food Administration, the New York Harbor Wage Adjustment Board of Arbitration, and the Port Facilities Commission.

The total amount of war work done during the fiscal year (exclusive of overtime) was equivalent to the services of 528 employees for one month, or 44 for one year. The total number of members of the Census force engaged on such work on July 1, 1918, was 92, and the number thus engaged on September 1, 1918, was 231.

ENLISTMENTS, CONTRIBUTIONS, RED CROSS WORK, ETC.

Members of Bureau's force enlisted and drafted into military and naval services.—During the fiscal year 47 members of the Census force entered the military and naval services. The total number who have entered those services from the outbreak of the war to September 15, 1918, is 64. Although the Bureau could ill spare the services of some of these men, no request was made to obtain deferred classification because of their Census employment.

Subscriptions for war purposes.—At the beginning of the First Liberty Loan campaign there was organized in the Bureau a "Liberty Loan Bond Club," which receives the semimonthly and monthly payments on bonds taken by the Bureau's employees on the installment plan and turns them over to the banks through which the bonds were purchased. The Bureau's subscriptions to the two loans made during the fiscal year 1918 (the second and third) totaled \$106,750, and the aggregate subscriptions to the first three loans amounted to \$164,800. The proportions of the force which subscribed for the bonds were 77.4 per cent at the first loan, 75.6 per cent at the second, and 89 per cent at the third. Since a large proportion of the Census employees were underpaid as compared with those in other Federal offices, and since at the time subscriptions were made for the third loan those who had bought their second loan bonds had not yet finished paying for them, the percentage of subscriptions to the third loan denotes a most commendable degree of self-sacrifice and a high spirit of patriotism on the part of the Census employees.

The total sales of War Savings Stamps and Thrift Stamps during the fiscal year to members of the Bureau's force amounted to \$8,506. Subscriptions to the Red Cross War Fund during the fiscal year by members of the Bureau's force aggregated \$2,773.

Red Cross Auxiliary.—Of the 11 companies composing the Red Cross Auxiliary organized in the Department of Commerce on June 13, 1918, 8 are made up of Census employees. In all, 275 employees of the Bureau, including contributing members, are represented in the Auxiliary.

SPECIAL AND MISCELLANEOUS LINES OF WORK.

MARRIAGE AND DIVORCE.

Marriage and divorce statistics for the calendar year 1916 have been collected and are now being compiled.

Statistics as to marriage and divorce covering the 40-year period from 1867 to 1906, inclusive, were collected and published, and the Census Bureau had had under contemplation the collection of similar statistics for the 10-year period 1907-1916. The amount of war work which the Bureau has been called upon to do, however, has been so great that it was decided to limit this inquiry to the single year 1916 instead of having it cover the entire decennium 1907-1916.

The canvass has been conducted entirely by correspondence, except that in 11 of the Southern States and in Missouri 142 of the Bureau's local cotton agents were employed in securing divorce reports for counties where the information could not be obtained directly from county officials. Complete statistics as to divorce were secured at the capitals of three States—Nebraska, New Jersey, and Wisconsin—and for the remaining States and the District of Columbia the information was obtained through the offices of the county and court clerks. In the case of the marriage statistics the information for 27 States was obtained from the State capitals or from printed reports, and for the remaining States the data were obtained through the county or court clerks or officials having custody of the marriage records. This method of conducting the canvass made possible a

considerable saving in expense, although naturally somewhat greater delay resulted in the cases of certain counties than would have occurred if agents had been sent into the field to collect the statistics. Substantially all the returns had been received by the close of the fiscal year 1918.

The preparation of the report had been in progress for some time prior to the termination of the canvass and is now near completion. The report will show, among other things, by counties, the number of marriages performed and the number of divorces granted during 1916, with detailed statistics for divorce, covering such matters as cause of divorce, party to whom granted, whether contested, place of marriage, whether alimony was asked and whether granted, and the extent to which children were affected by the decree.

CENSUS OF THE VIRGIN ISLANDS.

At the request of the Secretary of the Navy, the Director of the Census was instructed by the Secretary of Commerce, on October 1, 1917, to take a census of the Virgin Islands. This census, which was taken as of date November 1, 1917, covered population, agriculture, manufactures, fisheries, and wages and hours of labor. The work was done under the supervision of the chief statistician for manufactures, assisted by six other employees of the Department of Commerce, but the actual enumeration was made mainly by local employees.

Because of difficulty in securing transportation facilities, the representatives of the Bureau of the Census who were to supervise the work did not arrive at their destination until December 17. A conference was held with representatives of the naval government of the islands, at which the general plan and organization of the census were discussed. It was decided to utilize school-teachers in canvassing the towns, while local officials and owners of estates were relied upon to do the work in rural districts. The actual work of enumeration began on December 24 and was completed on January 12, and the census commission returned to the United States on the steamer leaving St. Thomas January 14.

The various sections of the report, with introduction and comprehensive appendixes, were prepared; the final proof was returned to the Government Printing Office, approved for printing, on July 9, 1918; and printed copies were received from the Printing Office on August 27.

UNITED STATES LIFE TABLES.

As shown in previous reports, the Bureau of the Census compiled a series of "life tables" based on the population in 1910 and the mortality in the three years 1909, 1910, and 1911 for the six New England States and New York, New Jersey, Indiana, Michigan, and the District of Columbia. These tables, which were published in June, 1916, are similar to those prepared by life insurance companies, but differ from the latter in that they relate to the entire population of the area covered instead of being limited to risks selected through medical examination or otherwise. The preparation of a similar series of tables exhibiting mortality conditions in 1890 and 1901

and during the decennium 1901 to 1910, inclusive, has been nearly completed, and the copy will be sent to the printer before the close of the present calendar year. The report presenting these tables will contain the original data on which they were based, together with an explanation of the methods employed in computing them; and in connection with certain tables there will be given commutation columns and data as to annuities and single and annual premiums at various rates of interest.

The preparation of these tables has been made subsidiary to the regular work of the Census Bureau, for which reason it has not been possible to complete and publish them sooner. Their value, however, is permanent, not ephemeral, and therefore will not be impaired in any material degree by the delay in their publication.

STATISTICAL DIRECTORY OF STATE INSTITUTIONS.

During the fiscal year the Bureau completed the compilation of the statistical directory of State institutions for the dependent, defective, and delinquent classes, of which mention was made in my former report, and copy for which has been sent to the Printing Office since the close of the year. This publication will show for each institution the number of inmates; cost of maintenance; value of plant; acreage of grounds or land; numbers of officials, assistants, and employees; and other data. The classes of institutions covered include State prisons and penitentiaries and State institutions for the insane, feeble-minded, epileptic, tuberculous, blind, deaf, and dependent. In addition to the data for the individual institutions the report presents general statistics for the States and summaries, with maps showing the location of the institutions, etc.

SEARCHING OF CENSUS RECORDS TO DETERMINE AGES.

During the fiscal year 5,043 searches were made of Census records to determine ages of pensioners. In addition, a great amount of work was done in searching the records to establish the ages of men who failed to register for military service.

FISHERIES OF NEW YORK CITY.

On August 23, 1917, the Director of the Census was authorized by the Secretary of Commerce to make a tentative collection of fisheries statistics for New York City covering the period from September 1 to December 31, 1917, the purpose being to determine the feasibility of making the inquiry a permanent one. The details of the method to be employed in doing the work were arranged by the Bureau of the Census and the Bureau of Fisheries. It was agreed that the reports should be collected by an agent of the Bureau of the Census and mailed directly to the Bureau of Fisheries for tabulation. An employee of the Census Bureau was therefore delegated to do the field work, and he proceeded to New York City and entered on duty September 1, 1917.

The data collected comprised (1) landings of fresh fish by American fishing vessels and boats, and (2) receipts of fresh fish by rail and steamer.

At the request of the Bureau of Fisheries the detail of the Census employee performing this work was extended until January 31, 1918, when it was decided to discontinue the undertaking.

TABULATION OF DATA FOR DISPUTED AREAS OF EUROPE AND AFRICA.

In the latter part of the fiscal year the Bureau, upon authorization of the Secretary of Commerce, began the tabulation of data taken from foreign censuses covering the disputed areas of Europe and Africa; that is, those areas whose final disposition will be determined by the outcome of the war. The data are obtained from foreign census reports, statistical yearbooks, official trade reports, and such other sources as are available.

PREPARATIONS FOR THE FOURTEENTH CENSUS.

In my last report I set forth the urgent need of making adequate preparations for the Fourteenth Census in order that the undertaking might be carried through without the delay and waste which would inevitably result from an eleventh-hour rush to make a start in the actual work under the handicap of a somewhat indefinite plan of campaign. I also outlined briefly the preparatory work which had already been done. The first task to which the Bureau set itself in this connection was a careful and detailed study of the act providing for the Thirteenth and subsequent decennial censuses, with a view to determining what amendments or changes were needed to meet the conditions under which the Fourteenth Census will be taken. After thorough consideration it was decided to recommend to Congress the enactment of an entirely new law, differing from the Thirteenth Census act in many details, but containing no radical changes. Such a bill was drafted and submitted to the House Committee on the Census, which held a series of hearings upon it during the period from February 20 to April 10, 1918. After the Director and other Census officials had been heard, the Secretary of Commerce, the Secretary of Agriculture, and representatives of the Bureau of Mines, the Geological Survey, and the Food Administration were called upon to express their views. On July 2, 1918, the House passed the bill with a few amendments of a minor character, and it is now pending in the Senate.

I can not too strongly emphasize the importance of promptly enacting this bill into law. If further action upon it should be deferred until the next session of Congress, which will be a short one, there is a considerable probability that it will not be passed at all by the present Congress, in which event there would be grave danger that the Census Bureau would find itself at the beginning of the Fourteenth Census period (July 1, 1919) without the full and definite knowledge which it should have as to the legal authority and requirements under which it must perform the great task of inventorying the population and industries of the United States. In certain respects the Bureau can not plan efficiently and intelligently for the coming census until it knows exactly what these legal requirements are to be.

The division of agriculture, which had gone out of existence at the close of the Thirteenth Census period, was reorganized and placed

under the charge of a chief statistician. During the fiscal year the major part of the work performed by this division consisted in preparations for the Fourteenth Census. During the week of August 20, 1917, a conference of the leading authorities on agriculture was held at the Bureau for the purpose of preparing a tentative schedule for the next census of agriculture. The schedule agreed upon was completed and printed during the month of December, and approximately 35,000 copies were mailed to county agents and township correspondents of the Department of Agriculture for distribution to farmers. More than 18,000 of these preliminary schedules, representing farms located in every county of the United States, had been returned to the Census Bureau up to September 1. Nearly all the schedules returned contained valuable information, and they were sorted, classified, and tabulated. The results obtained have been placed at the disposal of the Bureau of Crop Estimates of the Department of Agriculture, and will also be of service to the Office of Farm Management, the Bureau of Animal Industry, the Bureau of Markets, and the Bureau of Plant Industry.

Beginning on December 19, 1917, a conference was held at the Bureau of the Census for the purpose of discussing the irrigation inquiry which it is proposed to include in the Fourteenth Decennial Census, and preparing a schedule for use at that inquiry. This conference was attended by official representatives of the Departments of Agriculture and of the Interior and by representatives of several State universities. Photostat copies of the form of schedule adopted at this conference were sent to the irrigation economist for the Office of Public Roads and Rural Engineering of the Department of Agriculture for the purpose of making a test in several of the Western States. After the schedules have been filled by owners or operators of irrigation enterprises they will be forwarded to the Census Bureau for examination, criticism, and tabulation.

Beginning February 19, 1918, a conference was held at the Bureau, at which was discussed the drainage inquiry that it is planned to incorporate in the Fourteenth Census. This conference was attended by official representatives of the Departments of Agriculture and of War, representatives from several State universities, and a small number of leading engineers of the United States. The tentative schedule agreed upon has been prepared, but has not yet been printed.

There remains to be done much more preliminary Fourteenth Census work on agriculture, including studies concerning farm tenure, mortgage indebtedness, live stock, irrigation, drainage, special crops, and certain other special subjects; and in addition there is a vast amount of detail work in connection with the preparation and printing of schedules, tabulation sheets, etc.

It is the Census Bureau's plan, so far as the size of its force will permit, to have everything completed that can be completed before the beginning of the actual enumeration. However, the large amount of war work which the Bureau is being called upon to perform is necessarily interfering to some extent with these preparations.

PUBLICATIONS ISSUED.

Following is a list of the publications issued during the fiscal year and since its close. In addition, the Bureau has published a number of press summaries.

Class and title.	Date issued.	Pages.	Edition.
JULY 1, 1917, TO JUNE 30, 1918.			
Reports (cloth bound and of quarto size except as otherwise indicated):			
Birth statistics for the registration area of the United States: 1915 (paper).....	Aug. 7, 1917	78	5,000
General statistics of cities: 1916.....	Aug. 18, 1917	88	6,000
Financial statistics of cities: 1916.....	Sept. 22, 1917	375	6,500
Financial statistics of States: 1916.....	Sept. 4, 1917	127	3,500
Total.....		668	21,000
Bulletins (quarto):			
No. 135—Cotton production and distribution, season of 1916-17.....	Feb. 27, 1918	144	45,000
Census of manufactures, taken as of Dec. 31, 1914—			
States—			
Alabama.....	Sept. 22, 1917	29	1,300
Arizona.....	Oct. 27, 1917	15	700
California.....	July 25, 1917	63	2,600
Colorado.....	Oct. 12, 1917	29	1,400
Connecticut.....	Aug. 23, 1917	45	1,700
Delaware.....	Sept. 11, 1917	19	700
District of Columbia.....	Aug. 16, 1917	13	600
Florida.....	July 23, 1917	21	1,000
Illinois.....	Oct. 30, 1917	65	4,600
Iowa.....	Oct. 8, 1917	33	2,000
Kansas.....	Oct. 15, 1917	29	1,900
Kentucky.....	Aug. 29, 1917	27	1,200
Maine.....	Aug. 20, 1917	29	1,300
Maryland.....	Nov. 15, 1917	37	1,500
Massachusetts.....	Nov. 20, 1917	79	3,700
Michigan.....	Feb. 21, 1918	53	2,900
Minnesota.....	July 25, 1917	41	2,200
Missouri.....	Aug. 22, 1917	43	2,600
Montana.....	July 23, 1917	17	1,000
Nebraska.....	do.....	23	1,500
New Hampshire.....	Aug. 23, 1917	27	1,000
New Jersey.....	May 11, 1918	59	2,000
New Mexico.....	July 23, 1917	11	800
New York.....	May 10, 1918	147	6,500
North Dakota.....	Aug. 28, 1917	15	1,000
Ohio.....	Dec. 14, 1917	81	4,500
Oklahoma.....	Oct. 6, 1917	23	1,400
Pennsylvania.....	Dec. 14, 1917	97	6,500
South Carolina.....	July 23, 1917	21	1,100
Tennessee.....	do.....	31	1,500
Texas.....	Sept. 25, 1917	35	2,500
Virginia.....	Aug. 22, 1917	33	1,600
Washington.....	July 11, 1917	33	1,600
Wisconsin.....	Sept. 5, 1917	39	2,600
Total.....		1,362	71,000
Industries—			
Agricultural implements.....	Oct. 11, 1917	12	1,700
Automobiles, including bodies and parts.....	Oct. 15, 1917	19	2,500
Brass, bronze, and copper products.....	Nov. 26, 1917	11	2,200
Butter, cheese, and condensed milk.....	Aug. 31, 1917	23	5,250
Buttons, manufacture of.....	Nov. 15, 1917	9	1,700
Canning and preserving.....	Nov. 14, 1917	31	2,800
Carriages and wagons.....	Feb. 28, 1918	17	2,200
Cast-iron pipe.....	Dec. 8, 1917	7	1,300
Chemicals.....	Apr. 23, 1918	85	3,200
do.....	do.....	22	8,500
Clothing, manufacture of.....	Feb. 12, 1918	33	3,000
Cotton manufactures.....	Oct. 6, 1917	18	2,700
Electrical machinery, apparatus, and supplies.....	Oct. 19, 1917	8	2,000
Engines and machinery.....	Oct. 9, 1917	25	2,400
Gas, manufacture of.....	Aug. 20, 1917	9	1,300
Glucose and starch industry.....	Feb. 12, 1918	20	2,500
Hosiery and knit goods.....	Dec. 10, 1917	68	2,200
Iron and steel.....	Apr. 23, 1918	33	3,200
Leather industry.....	Oct. 11, 1917	8	1,200
Motorcycles, bicycles, and parts.....	Feb. 28, 1918	21	2,000
Musical instruments.....	Oct. 1, 1917	8	1,100
Needles and pins and hooks and eyes.....			

Class and title.	Date issued.	Pages.	Edition.
JULY 1, 1917, TO JUNE 30, 1918—continued.			
Bulletins (quarto)—Continued.			
Census of manufactures, taken as of Dec. 31, 1914—Continued.			
Industries—Continued.			
Oilcloth and linoleum.....	Aug. 20, 1917	8	1,000
Patent and proprietary medicines and compounds, and druggists' preparations.....	May 1, 1918	18	1,700
Petroleum, refining.....	Feb. 15, 1918	13	1,600
Printing and publishing.....	Mar. 4, 1918	49	7,200
Rubber industry.....	Feb. 12, 1918	15	1,700
Silk industry.....	Nov. 14, 1917	24	2,200
Slaughtering and meat packing.....	Jan. 23, 1918	25	3,750
Soap industry.....	July 11, 1917	11	1,600
Steam and electric cars and railroad repair shops.....	Feb. 21, 1918	23	2,500
Sugar industry.....	July 2, 1917	13	1,300
Textiles, including cordage and twine; jute goods and linen goods; flax and hemp, dressed; fur-felt hats; dyeing and finishing textiles; haircloth; mats and matting.....	Nov. 27, 1917	27	1,800
Turpentine and rosin.....	July 11, 1917	10	1,300
Wool manufactures.....	Apr. 23, 1918	48	2,200
Total.....		810	84,900
Miscellaneous publications:			
Legislation relating to Bureau of the Census.....	Aug. 29, 1917	71	100
Annual report of the Director of the Census to the Secretary of Commerce, fiscal year 1917 (octavo).....	Nov. 9, 1917	44	2,500
Physicians' pocket reference to the International list of causes of death (fourth edition) (2½ by 6 inches).....	June 4, 1918	28	200,000
Thirty-two reports, in card form, relating to cotton and cotton seed.....	July 14, 1917 to June 19, 1918	32	1,280,000
Four reports, in card form, relating to stocks of leaf tobacco.....	July 30, 1917 to Apr. 29, 1918	4	76,000
Total.....		179	1,553,600
Grand total, July 1, 1917, to June 30, 1918.....		3,163	1,780,500
JULY 1 TO AUGUST 31, 1918.			
Reports (cloth bound and quarto size except as otherwise indicated):			
Statistics of fire departments of cities having a population of over 30,000 (paper).....	Aug. 13, 1918	106	6,000
Census of the Virgin Islands of the United States: November 1, 1917 (cloth and paper).....	Aug. 27, 1918	147	4,000
Deaf-mutes in the United States: 1910.....	July 5, 1918	221	2,000
Total.....		473	12,000
Bulletin No. 136—Stocks of leaf tobacco.....	July 17, 1918	44	20,000
Miscellaneous publications:			
Manual of the International list of causes of death (third reprint, revised) (octavo).....	July 13, 1918	309	800
Advance tables of cotton production in the United States—crop of 1917 (quarto).....	July 27, 1918	40	42,000
Total.....		349	42,500
Grand total, July 1 to Aug. 31, 1918.....		866	74,500

MECHANICAL EQUIPMENT.

WORK IN MECHANICAL LABORATORY.

In addition to the maintenance of tabulating machinery for current use in the Census Bureau and the Bureau of Immigration, the Mechanical Laboratory was engaged during the fiscal year in the overhauling and new construction of machinery to be employed in the tabulation of the Fourteenth Census reports. This includes the construction of 25 new-model tabulating machines, complete, and of 5 extra bases, with full complement of counters; the rebuilding of 2

and the overhauling of 17 card-sorting machines; and the overhauling of 5 card-counting machines.

The new automatic tabulating machine, which was completed toward the close of the fiscal year 1917, was given a practical test in connection with the work of tabulating mortality data and was found to be entirely satisfactory in every respect and a great improvement over the machine used at the Thirteenth Census. This improved machine has been used as a model in the construction of the 25 tabulating machines mentioned above.

The present plans call for the completion of all parts entering into the construction of the equipment specified above before the expiration of the present fiscal year. In addition, it is planned, if the size of the force will permit, to expedite the assembling of these parts into complete machines.

The completion, on time, of the work to be done in the Mechanical Laboratory in preparation for the Fourteenth Census work will depend, in some degree, upon the acquisition and retention of skilled help. There appear to be no difficulties of a mechanical or technical character which can not be surmounted in time to make possible the complete equipment of the Bureau with the special and greatly improved machinery to be used in the tabulation of the Fourteenth Census statistics; but the difficulty in securing and retaining skilled help, owing to the increasing demand and higher rates of pay prevailing in manufacturing establishments outside, presents a serious problem.

INTEGRATING COUNTER.

In my former report I referred to the commencement of work on the development of an "integrating counter"—that is, a counter which will record and add numbers, instead of mere units, thus performing automatically the work done by the operator of an adding machine—for use in tabulating certain classes of the census data, such as those pertaining to agriculture and manufactures. This machine, like the unit-tabulating machine already in use, will work from punched cards which will be automatically fed into it. The numbers, indicated on the cards by the positions of the punched holes, will be automatically totalized precisely as a number is carried into the total by an adding machine when the proper lever or bar is depressed. Two or three sets of figures can be totalized at the same time.

Work was begun on the development of the integrating counter in the Census Bureau on July 6, 1917. In order not to interfere with the construction, overhauling, and rebuilding of the Bureau's regular tabulating equipment, it was necessary to organize a new force for work on the integrating counter and to purchase equipment for the building of the model. This has been done, and the work to date has shown good progress. The idea of the first model integrating counter has been developed and all drawings made; the patent situation has been carefully studied; and patterns, castings, and practically all parts have been made and are ready for assembling. The most difficult features of the work were undertaken first and have been completed, and the preliminary tests have shown satisfactory results.

OFFICE FORCE.

The appropriation act for the current fiscal year provided for 609 permanent officials and employees of the Census Bureau, representing an increase of 46 as compared with the preceding year. At the same time the numbers of positions in the various salary classes were readjusted so as to provide a somewhat better average salary scale than the Bureau has had heretofore. This readjustment will, it is hoped, diminish the tendency of the Census employees to seek more lucrative employment elsewhere, although the salary scale is still unduly low as compared with those existing in many other branches of the Federal Government. During the fiscal year 1918 there were 90 resignations from the Bureau's force, of which number only 20 were for the purpose of transfer to other positions in the classified civil service.

The greatest difficulty now experienced in connection with the personnel is in inducing eligibles on the civil-service registers to accept employment at the entrance salary of \$900. During the 14-month period from July 1, 1917, to August 31, 1918, inclusive, offers of appointment were tendered to 569 eligibles on the stenographer and typewriter, clerk, and other registers of the Civil Service Commission. Of these eligibles, 299 declined, 79 failed to reply, and 191—only one-third of the total number—accepted appointment.

The following statement shows the nature and distribution of the office and field forces on August 31, 1918:

OFFICIALS.

Director.....	SAM. L. ROGERS.
Chief clerk.....	THOMAS J. FITZGERALD.
Chief statisticians:	
Population.....	WILLIAM C. HUNT.
Statistics of cities.....	STARKS M. GREGAN.
Manufactures.....	EUGENE F. HARTLEY.
Vital statistics.....	WILLIAM H. DAVIS.
Agriculture, cotton and tobacco.....	WILLIAM L. AUSTIN.
Expert special agent in charge of revision and results.....	JOSEPH A. HILL.
Geographer.....	CHARLES S. SLOAN.
Expert chiefs of divisions:	
Administrative.....	TIMOTHY F. MURPHY.
Population.....	WILLIAM H. JARVIS.
Statistics of cities.....	EDWARD W. KOCH.
Manufactures.....	LEWIS A. CARRUTHERS.
Vital statistics.....	JOHN F. DALY.
Cotton and tobacco.....	EDWARD B. WHITE.
Revision and results.....	JOHN B. MITCHELL.
Chief, mechanical laboratory.....	WESLEY E. CILLEY.
	HARRY H. PIERCE.
	E. M. LABORTHAUX.

CLERICAL FORCE.

Stenographer, \$1,500.....	1	Clerks—Continued.	
Clerks:		\$1,000.....	90
Class 4.....	20	\$900.....	81
Class 3.....	30		
Class 2.....	65	Total.....	572
Class 1.....	285		

SUBCLERICAL FORCE.

Skilled laborers:		Assistant messengers, \$720.....	5
\$900.....	3	Messenger boys, \$480.....	4
\$720.....	1		
Unskilled laborers, \$720.....	4	Total.....	20
Messengers, \$840.....	3		

MECHANICAL-LABORATORY FORCE.

Expert, \$2,200-----	1	Tabulating mechanicians, \$1,400-----	2
Expert, \$2,000-----	1	Tabulating mechanician, \$1,200-----	1
Experts, \$1,800-----	2	Pressman and machinist, \$1,200-----	1
Mechanician, \$1,600-----	1	General mechanic, \$1,000-----	1
Mechanical draftsman, \$1,600-----	1	Apprentices, \$600 (temporary)-----	4
Toolmaker, \$1,600-----	1		
Electrician, \$1,400-----	1	Total-----	17

SPECIAL AGENT FORCE.

Special agents for general field work, etc-----	56
-------------------------------------------------	----

SUMMARY.

Officials-----	19	Mechanical-laboratory force-----	17
Clerical force-----	572	Special agents-----	56
Subclerical force-----	20	Total-----	684

In addition, there are employed throughout the cotton belt 701 local special agents to collect statistics of cotton and cotton seed. These agents perform their work only at intervals and are paid on a piece-price basis.

OFFICE ROOM AND STORAGE SPACE.

The beginning of the Fourteenth Census period (July 1, 1919) is now considerably less than a year distant, and the matter of providing adequate office accommodations for the Bureau during that period, as well as proper storage space for its permanent records, is one the importance and seriousness of which can not be overemphasized.

During the Thirteenth Census period (1909-1912) the Census Bureau's force was housed in no fewer than four buildings, one of which adjoined the main office, while the others were located at some little distance, one of them being nearly a mile away. The total floor space then occupied was approximately 200,000 square feet, for which an annual rental of \$40,000 was paid (no rental being charged for the 8,700 square feet occupied in the Maltby Building).

Even had the growth in the country's population and industries since the last census been but a normal one, the coming census would necessarily be a somewhat greater undertaking than the preceding one; but the abnormal changes which have taken place as a result of the war, especially in our manufacturing industries, will still further increase the complexity of the task. Naturally, therefore, the Bureau will need a greater amount of floor space than it had at the Thirteenth Census. Moreover, the necessity for storage space for such of the Census records as have permanent value is increasing rapidly from year to year, and with the great increase in the amount of such records at the next decennial census the needs will become acute. The old population schedules contain information of great value to genealogists, applicants for pensions, litigants, and others, and at present the data they afford as to dates of births of registrants for military service are of incalculable value in many cases where no birth records are available. It is obvious, therefore, that the destruction or serious injury of these old schedules would cause irreparable loss. Notwithstanding this, they are stored under conditions which tend to bring about their rapid deterioration.

It is estimated that during the next decennial census period the Bureau (whose force will then be between six and seven times as large as at present) will need about 275,000 square feet of space, including storage. Since the total floor space occupied by it in the Commerce Building on June 30, 1918 (exclusive of halls, toilet rooms, etc.), amounted to only 78,386 square feet, of which about 8,000 square feet represented storage space, and since there is practically no more room in the Commerce Building available for the use of the Bureau, the absolute necessity of finding other quarters for the greatly increased Census force during the Fourteenth Census period is apparent. It is highly undesirable to have the force scattered as it was during the Thirteenth Census. It is to be hoped, of course, that the war will have come to an end before the beginning of the next census period, in which event it may be possible to accommodate the extra force in some of the temporary buildings erected for the use of the two military departments and for the various special war agencies which have been created, thus bringing about a material saving in cost as compared with the previous census period. However, it is by no means safe to count upon this contingency as a certainty, because it is not at all likely that these buildings will be vacated immediately after the close of the war. In order that preparations may be made for sending out the enormous quantities of schedules and other supplies to the supervisors in charge of the field work a reasonable length of time in advance of January 1, 1920, the proposed date as of which the enumeration will be made, it will be necessary for a part of the Census force to move into other quarters several months in advance of that time—perhaps in September or October, 1919.

It is believed, therefore, that prompt steps should be taken looking toward the provision of a suitable building for housing the temporary Fourteenth Census force.

APPROPRIATIONS AND EXPENDITURES.

FINANCIAL STATEMENT, FISCAL YEAR 1918.

The following financial statement covers the operations of the Bureau of the Census during the fiscal year ended June 30, 1918:

Administrative:		
Salaries—		
Administrative and general	\$20,675.18	
Accounts and time	5,045.27	
Appointments	8,559.87	
Correspondence and distribution	8,676.76	
Editorial	2,726.50	
Mail	1,459.12	
Photostat	1,156.86	
Labor force	2,932.88	
Contingent expenses *	16,966.28	
		\$63,198.23
Machine shop:		
Salaries	24,635.23	
Materials, supplies, etc	13,571.84	
		38,206.57
Division of revision and results:		
Supervision	5,856.27	
Dependent, defective and delinquent classes	8,920.81	
Publications	4,152.88	
Official Register of the United States	5,012.21	
Negroes in the United States	2,801.71	
Directory of institutions	3,380.36	
Executive civil service	4,205.18	
Preparations for Fourteenth Census	253.56	
Miscellaneous	3,254.52	
		37,637.45

* Paid from appropriation for Department of Commerce; no separate appropriation for Bureau of the Census.

Division of population :		
Supervision	\$9,567.72	
Occupations	2,255.12	
Marriage and divorce	21,814.16	
Religious bodies	113,265.88	
Preparations for Fourteenth Census	5,824.82	
Miscellaneous	580.81	
		\$152,807.46
Division of manufactures :		
Supervision	11,048.90	
Census of manufactures for 1914	29,758.64	
Water transportation	86,039.89	
Electrical industries	92,208.98	
Shipbuilding	2,633.66	
Fisheries of New York City	1,267.83	
Preparations for Fourteenth Census	18,755.57	
		236,712.97
Geographer's division :		
Supervision	\$3,684.32	
Drafting	3,668.08	
Ages of pensioners and others	18,005.50	
Miscellaneous	8,895.97	
		34,253.83
Division of vital statistics :		
Supervision	7,192.38	
Mortality	91,172.28	
Births	70,422.58	
Life tables	2,280.55	
Miscellaneous	265.96	
		171,283.70
Division of statistics of States and cities :		
Supervision	8,107.86	
Financial and general statistics	79,074.83	
State statistics	17,868.33	
		104,551.02
Division of agriculture :		
Supervision	4,040.36	
Preparations for Fourteenth Census	14,122.71	
		18,163.07
Division of cotton and tobacco statistics :		
Supervision	5,291.38	
Cotton	252,807.38	
Tobacco	12,182.31	
Edible oils	70.74	
		269,801.81
Preparations for Fourteenth Census, general.		427.08
Special census of Virgin Islands.		6,754.75
Salaries of employees detailed to Department of Commerce.		1,228.66
Printing and binding *		96,487.31
War work :		
Registration	8,618.60	
Occupations of registrants	14,786.57	
Liberty Loans	6,601.53	
Housing Committee	1,171.68	
Railway wage scale	1,405.85	
War commodities and materials	11,434.26	
Manufacturing establishments using 100 tons or more of coal	3,033.86	
Miscellaneous war work	374.21	
		47,406.06
Grand total		1,283,618.55

Title of appropriation.	Appropriation.	Expenditures during fiscal year.
Salaries, Bureau of the Census, 1918	\$576,460.00	\$652,914.74
Collecting statistics, Bureau of the Census, 1918	647,000.00	^b 437,101.41
Tabulating machines, Bureau of the Census, 1918	60,000.00	37,165.41
Increase of compensation, Department of Commerce, 1918	42,983.40	42,983.40
Contingent expenses, Department of Commerce, 1918 ^a	16,966.28	16,966.28
Printing and binding, 1918 ^a	96,487.31	96,487.31
Total	1,539,896.99	1,283,618.55

^a Paid from appropriation for Department of Commerce; no separate appropriation for the Bureau of the Census.

^b The expenditures during the fiscal year for "collecting statistics" amounted to about \$210,000 less than the appropriation for that purpose. This resulted in large measure from the fact that the estimate on which the appropriation for collecting statistics was based included items for both decennial and annual statistics of marriage and divorce, whereas only an annual inquiry was made. It was the original intention to have the decennial inquiry cover the entire 10-year period 1907-1916 and to make the annual inquiry for the calendar year 1917. Later, however, because of the large amount of war work which the Census Bureau has been called upon to do, it was decided to drop the decennial inquiry but to make an annual inquiry for 1916.

APPROPRIATIONS, FISCAL YEAR 1919.

The Census Bureau's appropriations for the fiscal year 1919 aggregated \$1,349,240, as against \$1,383,460 for the preceding year.

The amount appropriated for salaries was increased from \$676,460 to \$739,240 in order to provide for 46 new statutory positions and for the readjustment of the salary scale so as to bring it more nearly into conformity with those for other branches of the Federal service.

The appropriation for collecting statistics was reduced from \$647,000 to \$490,000. This reduction was the net result of a number of changes, the most important of which were (a) the omission from the 1919 appropriation of items corresponding to those contained in the 1918 appropriation for statistics of marriage and divorce, lumber and timber products, and water transportation, and (b) increases in the items for statistics of electrical industries and preliminary Fourteenth Census work.

The appropriation for constructing tabulating machinery and for experimental work in developing an integrating counter remained unchanged at \$60,000; but a new item of \$60,000 was included in the current appropriation for the construction, purchase, rental, or repair of card-punching machines for use in compiling the results of the Fourteenth Census.

Respectfully,

SAM. L. ROGERS,
Director of the Census.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
COMMISSIONER OF FISHERIES

469

REPORT

OF THE

COMMISSIONER OF FISHERIES.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, September 30, 1918.

SIR: I have the honor to submit herewith a report in which are outlined the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1918. The major divisions, into which the report naturally falls, are general administrative matters, the propagation and distribution of food fishes, the artificial propagation of fresh-water mussels, the Bureau's relations with the fishing industry, biological and physical investigations and experiments, the Alaska fisheries service, the Alaska fur-seal service, protection of the minor fur-bearing animals of Alaska, and miscellaneous activities and relations.

GENERAL ADMINISTRATIVE MATTERS.

ADAPTATION TO WAR CONDITIONS.

The Bureau has continued to conduct its operations with reference to the peculiar situation created by war, and has actively cooperated with other governmental agencies—Army, Navy, Food Administration, War Trade Board, Shipping Board, Fuel Administration, etc.—in furthering the country's interests so far as its powers and resources permit. This has resulted in a curtailment of activities in certain lines, but in essential respects has given to the operations an importance never before assumed.

Seagoing vessels of the Bureau suitable for naval purposes have been placed at the disposal of the Navy Department and are rendering good service. The Navy Department has taken over the entire plant of the marine biological station at Beaufort, N. C. The extensive docks and spacious buildings at the marine station at Woods Hole, Mass., have been largely and constantly used as headquarters for a naval-reserve force.

The estimates of appropriations for 1920 have been submitted with reference to urgent conditions, which make unwise the expenditure of any moneys not actually required for operations on a war basis. Under other circumstances, larger appropriations would have been requested; and, in due time, such funds as the Bureau needs for the proper performance of its functions and the fulfillment of its obligations to the country will be estimated for and strongly urged before Congress, which in the past has dealt with this service in a liberal manner.

PERSONNEL.

The personnel of the Bureau, both at headquarters and in the field, has performed with efficiency and fidelity the ordinary duties devolving thereon, and, furthermore, has assumed in admirable spirit the added personal, official, and civic responsibilities imposed by the state of war. Throughout the Bureau, employees have freely offered themselves for active military duty; a comparatively large number have entered the Army and Navy; and in the relatively few cases in which deferred classification has been asked, the Bureau, rather than the employees themselves, has taken the initiative in recognition of certain definite needs of the fishery service. It is an honor no less than a pleasure to commend to the Secretary a loyal, capable corps of technical and clerical assistants, both permanent and temporary, to whom is to be attributed the success of the Bureau's operations and the enlarged scope and increasing public appreciation of its activities.

The administrative staff at headquarters during the fiscal year 1918 comprised the following persons: H. F. Moore, deputy commissioner; Irving H. Dunlap, assistant in charge of office; Henry O'Malley, assistant in charge of fish culture; Robert E. Coker, assistant in charge of inquiry respecting food fishes and the fishing grounds; Lewis Radcliffe, assistant in charge of statistics and methods of the fisheries; Ward T. Bower, chief agent of the Alaska service. At the beginning of the fiscal year 1919, Mr. O'Malley was transferred to the position of field assistant for the Pacific coast, a place newly created by Congress, and Glen C. Leach, field superintendent and an employee of the fish-cultural branch since 1902, became assistant in charge of the division.

The Bureau has long been handicapped by the extremely small salaries allowed by Congress in the lower grades, particularly in the clerical and fish-cultural forces. In recent years, and particularly in the fiscal year 1918, the situation has become acute because of the difficulty, often the impossibility, of inducing persons to accept statutory positions or of retaining persons who may have been willing to enter the service. The result is that a very large proportion of the low-grade positions in the fish hatcheries has been vacant much of the time, and there has been in the Washington office a floating corps of clerks, many of them appointed without regard to civil-service qualifications. The entrance salaries in the fish-cultural branch are so low as to be almost absurd under present industrial conditions. The clerical service is overcrowded at the bottom, and there is little opportunity for advancing capable and deserving juniors.

As a move toward the remedying of this situation, there has been included in the estimates of appropriations for 1920 provision for the substitution of a reduced number of higher-grade clerical positions in lieu of certain low-grade positions and for general increase in the salaries of the field force in the fish-cultural branch.

Other recommendations affecting personnel that have been placed in the estimates of appropriations for the next fiscal year are as follows: Increase in the salaries of assistants in charge of division; creation of a chief of the Alaska service; provision for eight additional technical assistants for work in fish culture, biological investigation, and commercial fisheries; provision for two new statistical

agents for canvassing the fisheries; a clerk to the deputy commissioner and a clerk for the Seattle office; change in designation and increase in salary of the principal Government officials on the Pribilof Islands; provision for personnel of the station at Block Island, R. I.; and an alternative estimate for the segregation of the different grades of all field employees, in lieu of detailed estimate by stations, cars, etc., as at present, in the interest of a more elastic force that can be more economically employed.

APPROPRIATIONS AND ALLOTMENTS.

The appropriations for the Bureau of Fisheries for the fiscal year 1918, including regular, deficiency, and special appropriations, aggregated \$1,263,560, as follows:

Salaries, including \$8,000 deficiency for steamer <i>Roosevelt</i>	\$440, 560
Miscellaneous expenses:	
Administration.....	10, 000
Propagation of food fishes.....	375, 000
Maintenance of vessels.....	90, 000
Inquiry respecting food fishes.....	50, 000
Statistical inquiry.....	7, 500
Protecting sponge fisheries.....	3, 000
Protecting seal and salmon fisheries of Alaska, including deficiency of \$35,000.....	110, 000
Developing aquatic sources of leather.....	10, 000
Repairs, steamer <i>Fish Hawk</i>	35, 000
Distribution cars.....	15, 000
Motor vessel for Woods Hole, Mass.....	3, 000
Rebuilding laboratory, Fairport, Iowa (deficiency).....	80, 000
Improvements and purchase of land at fish-cultural stations:	
Cape Vincent, N. Y.....	5, 500
Edenton, N. C.....	3, 500
San Marcos, Tex.....	7, 500
Improvements at fish-cultural stations:	
Bozeman, Mont.....	7, 500
Orangeburg, S. C.....	3, 500
Saratoga, Wyo.....	7, 000

A detailed statement of the expenditures under the foregoing appropriations will be submitted in accordance with law.

In addition to the amounts appropriated by Congress, there were provided for the extension of the Bureau's activities certain allotments from the fund for the national security and defense. These allotments, approved and authorized by the President on the recommendation of the Secretary, have enabled the Bureau to undertake important work that otherwise would have been altogether impossible or possible on only a limited scale.

The first allotment, amounting to \$30,000, was made on January 2, 1918, for the purpose of securing an immediate increase in the production of aquatic foods on all parts of the United States coast, through such educational and publicity methods as have heretofore proved successful.

The second allotment, of \$20,000, was given on February 27, 1918, to enable the Bureau to cooperate with the Food Administration and the State fishery authorities in increasing the production of food fish in the Gulf States.

On April 9, 1918, an allotment of \$25,000 was provided for the purpose of enabling the Bureau to install at the Pribilof Islands a plant for the utilization of seal carcasses in producing a commercial

grade of oil and fertilizer. It was represented that, by the use of material that would otherwise be wasted, valuable by-products would result that would pay for the plant in the first season of its operation.

On July 2, 1918, pursuant to a formal presentation of the matter on June 23, 1918, the President allotted \$125,000 to permit the erection and maintenance of a fisheries-products laboratory in Washington, D. C. The primary purpose of the laboratory is to induce increased production and consumption of aquatic foods through the dissemination of knowledge of improved methods of preservation.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

PROGRESS OF FISH CULTURE.

The general trend and progress of Federal fish culture may be regarded as satisfactory. Some of the great commercial fisheries which, because of their magnitude and intensity, have a constant tendency to affect adversely the abundance of the fishes sought have been brought well within the control of the fish-culturist and may, in general, be maintained at a high level because of the advances that have been made in artificial propagation, supplemented by minimum rational restrictions.

Other fisheries, of which the lobster and sturgeon are conspicuous examples, have long been prosecuted in such flagrant and notorious disregard of the laws of nature and of man that artificial propagation seems hopeless, and dependence thereon only serves to condone pernicious practices. An exception should, of course, be made in the case of lobster rearing which, if conducted on a sufficiently extensive scale in the principal centers of the lobster fishery, and supported by local popular sentiment in favor of lobster conservation, would undoubtedly do much to arrest the decline and restore depleted waters.

Of the littoral marine fishes that have come under artificial propagation, the winter flounder is most extensively hatched and supports the largest fishery. It is most worthy of continued attention at the hands of the fish-culturist, because of its inherent qualities and because its abundance may readily be affected, favorably or unfavorably, by man.

Judged by mere numbers, the fish-cultural work of the Bureau in the fiscal year 1918 showed a decrease of approximately 20 per cent compared with 1917. The aggregate output of the hatcheries was 4,098,105,000. The smaller production was chiefly attributable to adverse weather conditions prevailing during the spawning time of various commercial fishes whose eggs are handled in large numbers, particularly the cod, pollock, and pike perch. Other species which showed a reduced output were shad, cisco, humpback and chum salmons, lake trout, smelt, white perch, and lobster. An increase is to be noted in the production of buffalofish, carp, catfish, whitefish, chinook and sockeye salmons, yellow perch, and winter flounder.

From the very nature of the fish-cultural work, the young of some of the species hatched are planted as fry, and this will no doubt continue to be the practice for many years to come, perhaps indefinitely. The fishes so handled are those whose eggs are obtained in comparatively large numbers from the commercial fishermen and whose fry have a very short yolk-sac stage, common examples being the whitefish, shad, pike perch, yellow perch, striped bass, and vari-

ous marine species. Other fishes, however, which in the early days of fish culture also were planted soon after hatching, are now being held for longer and longer periods as the facilities for rearing are improved; and a conspicuous feature of the recent operations is the greatly increased percentage of fishes liberated as fingerlings and yearlings. The fishes which require this treatment are the salmons and trouts, which have a large, slowly absorbed yolk-sac, the carrying of which renders them more or less helpless and a ready prey to their natural enemies, and the fresh-water basses, which are especially adapted for pond culture. In the fiscal year 1918, over 168,000,000 fish were distributed by the Bureau as fingerlings, yearlings, and adults, this being by far the largest output of such fish, both in actual number and in percentage. The year 1917, which established a record in this respect, showed only 82,000,000 fishes distributed as fingerlings, yearlings, and adults. It should be understood that fishes stranded on the overflowed lands along the Mississippi River and tributaries and rescued by the Bureau's agents are included in the foregoing figures.

There follows a summarized statement of the output of the Bureau in 1918:

SUMMARY, BY SPECIES, OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1918.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total
Catfish.....			12,733,330	12,733,330
Carp.....		3,250,000	1,060,941	4,910,941
Buffalofish.....		28,280,000	2,417,062	30,697,062
Shad.....		52,543,900		52,543,900
River herring.....		100,000	3,700,000	3,800,000
Whitefish.....	75,540,000	408,492,000		484,032,000
Lake herring (clisoo).....		65,130,000		65,130,000
Silver salmon.....		960,300	10,534,115	11,514,415
Chinook salmon.....	17,574,900	6,028,920	63,176,244	86,780,064
Sockeye salmon.....	13,000,000	38,137,000	45,599,785	96,736,785
Humpback salmon.....		5,193,065	3,754,000	8,947,065
Chum salmon.....		9,892,145		9,892,145
Steelhead salmon.....	1,570,000	172,000	7,022,488	8,764,488
Rainbow trout.....	1,139,250	22,000	1,654,477	2,815,727
Atlantic salmon.....		2,577,900	671	2,577,671
Landlocked salmon.....	478,000	305,395	87,837	872,232
Blackspotted trout.....	1,080,000	3,821,000	1,878,500	6,780,500
Loch Leven trout.....			56,000	56,000
Lake trout.....	21,718,000	39,599,200	226,797	61,543,997
Brook trout.....	378,175	3,876,265	7,882,068	12,137,108
Sumapee trout.....			7,372	7,372
Smelt.....		1,218,750		1,218,750
Pike and pickerel.....			106,408	106,408
Fresh-water drum.....			83,473	83,473
Crappie.....			2,905,812	2,905,812
Largemouth black bass.....		283,500	970,020	1,253,520
Smallmouth black bass.....		172,500	155,674	328,174
Rock bass.....			83,055	83,055
Warmouth bass.....			9,220	9,220
Sunfish.....			1,644,558	1,644,558
Pike perch.....	14,560,000	56,000,000	1,964	70,561,964
Yellow perch.....		182,899,000	459,282	183,358,282
White perch.....		2,900,000		2,900,000
White bass.....			47,261	47,261
Striped bass.....		14,349,000		14,349,000
Mackerel.....		4,648,000		4,648,000
Cod.....		77,659,000		77,659,000
Pollock.....		233,700,000		233,700,000
Haddock.....		17,830,000		17,830,000
Winter flounder.....		2,455,371,000		2,455,371,000
Miscellaneous fishes.....			100,200	100,200
Lobster.....		66,680,000	5,700	66,685,700
Total.....	147,048,325	3,782,091,940	168,964,894	4,098,105,159

HATCHERIES OPERATED.

No new hatcheries were in operation during the year. The hatchery near Havre de Grace, Md., at the mouth of the Susquehanna River, closed by order of the Secretary in the last fiscal year, has remained closed. The Bureau is not informed of any action taken by the Maryland Legislature that would justify the reopening of this station. The equipment has been largely removed for use in other fields. The station at San Marcos, Tex., closed by order of the Secretary in May, 1917, was reopened July 1, 1918, the Texas Legislature having in March, 1918, enacted a law to meet the requirements imposed by Congress. Following is a list, in alphabetical order, of the fish-cultural stations operated during the year, with the principal auxiliary or subsidiary stations thereunder, the period of active work, and the species handled. The numerous minor field stations and mere egg-collecting points are not shown.

Congress has provided a permanent personnel for the Berkshire trout hatchery, and regular operations thereat have begun. Although the donation of this valuable property was formally accepted by the Government in July, 1916, the Department of Justice has not yet made the report on the title, as required by law, so that the Bureau has not been able to assume formal control.

FISH-CULTURAL STATIONS AND PRINCIPAL AUXILIARIES OPERATED DURING THE FISCAL YEAR, 1918.

Designation.	Period of operation.	Species handled.
Aloknak, Alaska.....	Entire year.....	Sockeye and humpback salmon.
Seal Bay, Alaska.....	July-October.....	Do.
Achtalaya, La.....	March-April.....	Buffalofish.
Baton Rouge, La.....	April-May.....	Black bass, buffalofish, carp, catfish, crappie, drum, sunfish, white bass.
Baird, Cal.....	Entire year.....	Chinook salmon.
Battle Creek, Cal.....	do.....	Do.
Mill Creek, Cal.....	do.....	Do.
Hornbrook, Cal.....	do.....	Chinook salmon, rainbow trout.
Baker Lake, Wash.....	do.....	Sockeye, chinook, and silver salmon.
Birdsview, Wash.....	do.....	Sockeye, chinook, chum, humpback, silver, and steelhead salmon.
Brimson, Wash.....	July-February.....	Chum, humpback, and steelhead salmon.
Darrington, Wash.....	do.....	Chinook, chum, humpback, silver, and steelhead salmon.
Day Creek, Wash.....	July-May.....	Chinook, chum, and steelhead salmon.
Duckabush, Wash.....	Entire year.....	Chum, humpback, silver, and steelhead salmon.
Hlabott Creek, Wash.....	July-January.....	Chinook, chum, humpback, silver, and steelhead salmon.
Quilcoene, Wash.....	Entire year.....	Chum, humpback, silver, and steelhead salmon.
Sultan, Wash.....	do.....	Chinook, humpback, silver, and steelhead salmon.
Berkshire, Mass.....	do.....	Brook and rainbow trout, steelhead salmon.
Boothbay Harbor, Me.....	do.....	Flounder, lobster.
Bosman, Mont.....	do.....	Blackspotted, brook, and rainbow trout.
Meadow Creek, Mont.....	March-June.....	Rainbow trout.
Yellowstone Park, Wyo.....	July, August, and June.....	Blackspotted trout.
Bryans Point, Md.....	March-May.....	Shad, yellow perch, alewife.
Cape Vincent, N. Y.....	Entire year.....	Brook, lake, and rainbow trout, lake herring, pike, and yellow perch, whitefish.
Central station, Washington, D. C.....	do.....	Black bass, brook trout, humpback, salmon, shad, sunfish, whitefish.
Clackamas, Oreg.....	do.....	Blackspotted, brook, and rainbow trout, chinook, silver, and steelhead salmon.
Applegate, Oreg.....	do.....	Chinook, silver, and steelhead salmon.
Big White Salmon, Wash.....	do.....	Chinook, salmon.
Little White Salmon, Wash.....	do.....	Do.
Rogue River, Oreg.....	do.....	Blackspotted trout, chinook, silver, and steelhead salmon.
Upper Clackamas, Oreg.....	do.....	Rainbow trout, chinook, silver, and steelhead salmon.

FISH-CULTURAL STATIONS AND PRINCIPAL AUXILIARIES OPERATED DURING THE FISCAL YEAR, 1918—Continued.

Designation.	Period of operation.	Species handled.
Clackamas, Oreg.—Contd.		
Willamette, Oreg.....	July, May, and June....	Shad.
Astoria, Oreg.....	.....do.....	Do.
St. Helens, Oreg.....	.....do.....	Do.
Cold Springs, Ga.....	Entire year.....	Black bass, catfish, sunfish.
Craig Brook, Me.....	.....do.....	Atlantic, humpback, and landlocked salmon, brook trout.
Duluth, Minn.....	.....do.....	Brook and lake trouts pike perch whitefish.
Edenton, N. C.....	.....do.....	Black bass, shad, sunfish, yellow perch.
Weldon, N. C.....	April-May.....	Striped bass.
Erwin, Tenn.....	Entire year.....	Brook and rainbow trouts, black bass, carp, rock bass, sunfish.
Fairport, Iowa.....	.....do.....	Black bass, buffaloish, carp, catfish, crappie, drum, pike, sunfish, white bass yellow perch.
Gloucester, Mass.....	.....do.....	Cod, flounder, haddock, pollock.
Green Lake, Me.....	.....do.....	Brook and lake trouts, landlocked salmon smelt.
Grand Lake Stream, Me.....	.....do.....	Lake trout, landlocked salmon, white perch.
Homer, Minn.....	.....do.....	Black bass, buffaloish, carp, catfish, crappie, pike perch, pike, rock bass, sunfish, white bass, yellow perch.
La Crosse, Wis.....	.....do.....	Black bass, buffaloish, carp, catfish, crappie, drum, pike, white bass, pike and yellow perches, brook and rainbow trouts.
Leadville, Colo.....	.....do.....	Blackspotted, brook, lake, Loch Leven, and rainbow trouts.
Louisville, Ky.....	.....do.....	Brook and rainbow trouts, black bass, crappie, pike perch, rock bass, smallmouth bass, sunfish.
Mammoth Spring, Ark.....	.....do.....	Black bass, rock bass.
Manchester, Iowa.....	.....do.....	Brook and rainbow trouts, crappie, rock bass, smallmouth bass.
Bellevue, Iowa.....	July-December.....	Black bass, buffaloish, carp, catfish, crappie, drum, pike, river herring, sunfish, warmouth bass, white bass, yellow perch Do.
North McGregor, Iowa.....	.....do.....	Black bass, buffaloish, carp, catfish, crappie, drum, rock bass, smallmouth bass sunfish, yellow perch.
Mercedosa, Ill.....	.....do.....	Black bass, buffaloish, carp, catfish, crappie, drum, rock bass, smallmouth bass sunfish, yellow perch.
Nashua, N. H.....	Entire year.....	Brook and rainbow trouts, landlocked salmon, smallmouth bass.
Nesho, Mo.....	.....do.....	Black bass, crappie, rock bass, smallmouth bass, sunfish, yellow perch, rainbow trout.
Northville, Mich.....	.....do.....	Brook, lake, and rainbow trouts, smallmouth bass, steelhead salmon.
Alpena, Mich.....	October-March.....	Lake trout, whitefish.
Charlevoix, Mich.....	November-June.....	Lake trout, steelhead salmon, whitefish.
Orangeburg, S. C.....	Entire year.....	Black bass, sunfish.
Put in Bay, Ohio.....	.....do.....	Carp, lake trout, pike perch, whitefish.
Quinsnit, Wash.....	.....do.....	Sockeye, chinook, and silver salmon.
St. Johnsbury, Vt.....	.....do.....	Brook, lake, rainbow, and sunapee trouts, landlocked and steelhead salmon, smallmouth bass.
Holden, Vt.....	.....do.....	Brook and lake trouts, landlocked and steelhead salmon.
Swanton, Vt.....	April-June.....	Pike and yellow perches.
Saratoga, Wyo.....	Entire year.....	Blackspotted, brook, and rainbow trout, steelhead salmon.
Spearfish, S. Dak.....	.....do.....	Blackspotted, brook, lake, and rainbow trout.
Springville, Utah.....	.....do.....	Blackspotted, brook, and rainbow trouts.
Tupelo, Miss.....	.....do.....	Black bass, crappie, sunfish warmouth bass.
Friar Point, Miss.....	July-December.....	Black bass, catfish, crappie, rock bass, sunfish.
White Sulphur Springs, W. Va.....	Entire year.....	Brook and rainbow trouts, smallmouth bass.
Woods Hole, Mass.....	.....do.....	Cod, flounder, mackerel.
Wytheville, Va.....	.....do.....	Brook and rainbow trouts, black bass, rock bass, smallmouth bass, sunfish.
Yee Bay, Alaska.....	.....do.....	Sockeye salmon.

DISTRIBUTION OF FOOD FISHES.

The food fishes produced at the Bureau's stations and assigned to private applicants, State fishery authorities, or public waters, received a nation-wide distribution.

The 6 special cars employed in distributing the output in 1918 traveled 102,330 miles, of which 10,024 miles were without cost to the Bureau. The remaining mileage was at a cost of 10 to 25 cents per mile, which includes moving of cars and fares of attendants. Car messengers, detached from their cars and charged with special shipments of fish, traveled 468,244 miles, of which 54,578 miles were free and the remainder at 2 to 4 cents per mile. The cars were hauled over 47 railroads and the messengers traveled on 190 different railroads.

Poor service rendered by express companies during the year, owing in part to railway congestion and in part to neglect of explicit instructions, resulted in the loss of various shipments of fish eggs to State fishery authorities and between stations of the Bureau.

RELATIONS WITH STATES AND FOREIGN COUNTRIES.

In cooperation with the fishery authorities of the various States, the Bureau has continued to supply considerable numbers of fish eggs for incubation in State hatcheries, the resulting fish being planted in local waters under the direction of the State commissioners. Limited numbers of fry, fingerlings, yearlings, and adults also are furnished to the States. In 1918 this form of cooperation was extended to 27 States, as follows:

ALLOTMENTS OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS, FISCAL YEAR 1918.

[All figures are for eggs unless otherwise indicated. Fingerlings are designated e and fry b.]

State and species.	Number.	State and species.	Number.
California: Chinook salmon.....	14,321,900	Montana:	
Connecticut:		Blackspotted trout.....	300,000
Largemouth black bass.....	e 515	Largemouth black bass.....	e 1,400
Catfish.....	e 750	Catfish.....	e 3,000
Crappie.....	e 1,500	Rainbow trout.....	300,000
Sunfish.....	e 2,400	Sunfish.....	e 100
Illinois:		Nebraska: Rainbow trout.....	e 16,000
Largemouth black bass.....	e 825	Nevada:	
Catfish.....	e 12,200	Blackspotted trout.....	50,000
Crappie.....	e 21,850	Rainbow trout.....	50,000
Lake trout.....	100,000	New Hampshire:	
Pike and pickerel.....	e 683	Lake trout.....	100,000
Sunfish.....	e 9,730	Pike perch.....	2,000,000
White bass.....	e 2,665	Whitefish.....	500,000
Whitefish.....	5,000,000	New Jersey:	
Yellow perch.....	e 2,575	Largemouth black bass.....	e 200
Iowa:		Landlocked salmon.....	25,000
Brook trout.....	50,000	Rainbow trout.....	50,000
Lake trout.....	50,000	Steelhead salmon.....	50,000
Rainbow trout.....	94,000	New York:	
Kentucky:		Lake trout.....	11,708,000
Brook trout.....	e 600	Landlocked salmon.....	50,000
Pike perch.....	b 2,400,000	Steelhead salmon.....	400,000
Rainbow trout.....	e 1,600	Whitefish.....	15,000,000
Maine:		Ohio: Lake trout.....	700,000
Brook trout.....	100,000	Oklahoma:	
Lake trout.....	100,000	Rock bass.....	e 1,550
Landlocked salmon.....	378,000	Sunfish.....	e 1,550
Maryland:		Yellow perch.....	e 100
Catfish.....	e 180	Yellow perch.....	b 10,000
Crappie.....	e 200	Oregon:	
Smallmouth black bass.....	e 88	Brook trout.....	e 26,000
Massachusetts: Pike perch.....	5,000,000	Chinook salmon.....	? 150,000
Michigan: Lake trout.....	2,550,000	Sockeye salmon.....	3,000,000
Minnesota:		Steelhead salmon.....	750,000
Lake trout.....	300,000	Pennsylvania: Whitefish.....	28,280,000
Steelhead salmon.....	50,000		

ALLOTMENTS OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS, FISCAL YEAR 1918—Continued.

State and species.	Number.	State and species.	Number
Rhode Island:		Washington:	
Brook trout.....	50,000	Blackspotted trout.....	200,000
Smallmouth black bass.....	20,000	Lake trout.....	300,000
South Dakota:	690	Wisconsin:	
Largemouth black bass.....	1,050	Largemouth black bass.....	3,425
Brook trout.....	8,000	Catfish.....	900
Catfish.....	12,300	Crappie.....	1,200
Crappie.....	2,200	Lake trout.....	5,402,000
Sunfish.....	5,100	Whitefish.....	15,000,000
Tennessee:		Wyoming:	
Brook trout.....	25,000	Blackspotted trout.....	200,000
Rainbow trout.....	100,000	Rainbow trout.....	50,000
Vermont:		Steelhead salmon.....	50,000
Lake trout.....	300,000		
Landlocked salmon.....	10,000	Total.....	133,307,900
Pike perch.....	7,056,000		2,410,000
Steelhead salmon.....	50,000		170,771

In various fields the agents of the Bureau and the different States have joined forces in the collection of eggs. The States, on their part, have facilitated the fish-cultural work of the Bureau, and an excellent cooperative spirit prevails throughout the country. Especially helpful during the fiscal year 1918 was the assistance rendered by the fishery officials of the States of Vermont, New York, Michigan, Wisconsin, Minnesota, Illinois, Iowa, Louisiana, Utah, Washington, and Oregon. Before supplying to individuals or organizations fishes not indigenous to given States, the Bureau takes the precaution of referring the applications to the State officials and securing their approval.

An assignment of sockeye-salmon eggs was made from Alaska to British Columbia, with the intention of having the resulting young planted in the Fraser River. The shipment arrived in bad condition, and only comparatively few young were produced. Limited consignments of chinook-salmon and rainbow-trout eggs were made to Japan, and small numbers of black bass and yellow perch were sent to Mexico. At the request of the authorities of the Canal Zone, 7,875 fingerling black bass, carp, catfish, and sunfish were planted in Gatun Lake. The details of the foreign shipments are as follows:

SHIPMENTS OF FISH AND FISH EGGS TO CANAL ZONE AND FOREIGN COUNTRIES DURING THE FISCAL YEAR 1918.

Canada: Sockeye salmon.....	eggs.....	10,000,000
Japan:		
Chinook salmon.....	do.....	100,000
Rainbow trout.....	do.....	100,000
Mexico:		
Largemouth black bass.....	fingerlings.....	750
Yellow perch.....	do.....	200
Canal Zone:		
Largemouth black bass.....	do.....	1,000
Carp.....	do.....	1,875
Catfish.....	do.....	3,000
Sunfish.....	do.....	2,000

The possibilities of increased fish-cultural work on the Great Lakes, particularly on Lakes Erie and Ontario, as a result of more intimate cooperation between the United States and Canada have recently become more evident, and arrangements have been made by which all available sources of egg supply will be exploited. Especially valuable during recent seasons has been the courteous action of the fishery officials of Canada in opening to spawn takers from the Cape Vincent station the whitefish spawning grounds in the Bay of Quinte, Lake Ontario.

RESCUE OF STRANDED FISHES.

The important work of rescuing food fishes from landlocked waters in districts of the Mississippi and Illinois Rivers assumed a wider scope and produced more noteworthy results than in previous years. All of the important old fields were occupied and some new territory was covered, the operations extending from Minnesota to Louisiana, both States inclusive. The principal centers of rescue work were Homer, Minn.; La Crosse, Wis.; Fairport, North McGregor, and Bellevue, Iowa; Meredosia, Ill.; Friar Point, Miss.; and Baton Rouge, La.

With a view to an increased output and a reduced unit cost several valuable new features were introduced in 1918, including the stationing in the immediate vicinity of the rescuing parties of houseboats to be used as living quarters for the fishing crews and improvements to the tank equipment for the holding and hardening of fish intended for transfer to distant points.

The number of food fishes rescued in the fiscal year 1918 was 25,970,041, as against 9,885,005 in 1917. The number of each of the important species was as follows:

Black bass, largemouth	365, 424
Black bass, smallmouth	2, 433
Buffalofish	2, 417, 052
Carp	1, 660, 776
Catfish	12, 718, 930
Crappie	2, 899, 462
Drum	83, 473
Pike	106, 408
Pike perch	1, 954
River herring	3, 700, 000
Rock bass	5, 940
Sunfish	1, 393, 835
Warmouth bass	7, 970
White bass	47, 261
Yellow perch	458, 923
Miscellaneous	100, 200

Total 25, 970, 041

A very large percentage of the fishes rescued are returned to the adjacent open waters of the rivers and are not liable again to be stranded for another year; meanwhile they will have increased in size and economic value. Small numbers of these fishes of all species, but particularly black bass, crappie, sunfish, and catfish, are used by the Bureau in filling applications for stocking ponds, lakes, and streams in the adjoining or remote States. The fish thus delivered

to applicants aggregated 692,732, or less than 3 per cent of the total number handled.

The importance of this work arises from (1) its insignificant cost, (2) the inevitable waste of the fishes unless they are salvaged, and (3) the recognized edible qualities of all the fishes thus saved and the great mass of wholesome food they represent. The results are such as merit adequate financial support, so that the whole vast territory may be adequately covered each year and every available young food fish that would otherwise perish may be saved for ultimate consumption by man.

ACCLIMATIZATION.

In November, 1917, a carload of adult eastern lobsters, numbering 6,000 equally divided as to sex, was sent from Boothbay Harbor, Me., via Bath, to Anacortes, Wash., in charge of Superintendent E. E. Hahn. The lobsters arrived at their destination on November 13, having been in transit since the 7th instant. The loss was only 5 per cent, and the shipment was regarded as the most successful of its kind. After a lot of 60 was reserved for experimental work, the lobsters, all in a very healthy, vigorous condition, were transferred to live cars, towed to the San Juan Islands, and liberated at selected points.

This was the sixth lot of adult lobsters sent by the Bureau to Puget Sound in recent years in the effort to establish this valuable creature on the Pacific Coast. In arranging for the shipment special precautions were taken, not only in the selection of the stock, but in the preparation of packing cases and material. The consignment included only individuals that had been carefully hardened in advance. The experience of the previous year having demonstrated the utility of a special barrel, built with shelves in the center at intervals of 6 inches and provided with ice compartments on either side, 40 such barrels, or a sufficient number to hold one-third of the shipment, were constructed. The remaining lobsters were carried in 130 specially designed crates, two layers to the crate, and in 90 large boxes having one layer each. All straw used for packing was first immersed in strong brine. All the packages carried well, but the lobsters in the shallow boxes with brine-soaked straw were somewhat stronger, and this method has apparently advantages over the others and leaves little to be desired for long-distance shipments.

Arrangements are being made to conduct a thorough search for eastern lobsters in Puget Sound, by setting regular lobster pots in charge of competent fishermen. As showing the apparent adaptability of the lobsters to these waters, it may be noted that those reserved from the November shipment and retained in a live car at Anacortes remained in excellent condition, taking culled canned salmon regularly, and sustaining a loss of only four, until January 17, 1918, when they escaped during an unusually high tide.

Noteworthy results have attended the acclimatization of the humpback or pink salmon on the coast of Maine, and the possible economic outcome appears to justify a continuance of the work.

From a shipment of 1,000,000 humpback eggs from Puget Sound arriving at the Craig Brook station in November, 1917, 934,235 fry

were hatched in January; and during March and April the resulting fingerlings were planted in Dennys and Pembroke Rivers, at points 2 to 4 miles above tidewater.

In August, September, and October, 1917, many thousand humpbacks entered rivers in eastern Maine. A few fish were observed or reported in Penobscot, St. George, Medomac, St. Croix, and other streams, but the principal runs were in Dennys and Pembroke Rivers.

Several representatives of the Bureau visited streams in which the humpbacks were reported and secured first-hand information regarding the runs. Arrangements were made to take eggs for hatching purposes, but the run at any given point was so short after the arrival of the fish-culturist that only a few thousand eggs could be obtained, most of the fish being spent. Net fishing at this season is prohibited by the local law, and a considerable number of the fish were able to spawn naturally, although the conditions for the passage of fish up some of the streams could be greatly improved by the installation of fishways.

At the dam in Penobscot River at Bangor 10 humpbacks were captured between August 13 and 31. In Pembroke River, on September 27, at a time when the salmon were present by hundreds, the State fish warden collected 25 specimens and placed them above the dam at Pembroke. In Dennys River, in the vicinity of Dennysville, during the week of September 29–October 6, at least 1,200 adult humpbacks were seen and many more fish were known to be in the deep pools and on the rips about 6 miles upstream from the head of tidewater. Many fish congregated under some large rafts of logs in that section and could not be driven out, so that their number could not be estimated. On one visit of a fish-culturist from the Craig Brook hatchery about 50 fish were seen on the rips. Altogether, at least 2,000 fish were observed in Dennys River and 500 in Pembroke River.

Some poaching on the part of the people living on the streams occurred, and the pickling of humpbacks on Pembroke River was reported, the fish having been taken with pitchforks. Some people at Dennysville were reported to have been made ill by eating a humpback that had been picked up by a small boy as it drifted downstream in a moribund condition after having spawned. The superintendent of the Craig Brook station went among the river people and advised them that these fish are not suitable for food when in spawning condition and should be eaten only when taken in salt water or immediately after coming in from the sea.

A number of specimens of humpbacks from Dennys River were forwarded to Washington, and one of them, weighing 6½ pounds and 22 inches in length has been on exhibition in the Secretary's office. The average weight of the fish observed by the Bureau's agents was about 5 pounds; the largest, a male, weighed 10 pounds 9 ounces, and the smallest, a female, weighed 2½ pounds. Some examples, together with a collection of scales from others, have been examined by Dr. Charles H. Gilbert, the well-known authority on the Pacific salmon, and it is shown therefrom that the humpback in its new environment retains its Pacific habit of proceeding to the ocean shortly after it begins to swim and returning to the rivers to spawn and die when 2 years old.

ARTIFICIAL PROPAGATION OF FRESH-WATER MUSSELS.

The work of propagating fresh-water pearly mussels at various places in the basin of the Mississippi River was conducted as usual under the direction of the Fairport laboratory. The number of young mussels (glochidia) liberated in a condition of parasitism on fishes was 209,132,800, as compared with 252,478,700 in the fiscal year 1917. The decrease was largely accounted for by the fact that during a considerable portion of the season most favorable for collecting the fish hosts very few of the mussels were gravid. This was especially the case with the mucket, the principal mussel handled. The number of fishes infected prior to release was 252,259, of which 159,190 were seined in open waters, 83,982 were rescued from land-locked pools and lakes, and 9,087 were propagated and reared at the Fairport station.

Three new fields for mussel propagation were opened during the year, namely, New Boston, Ill., on the Mississippi, a point on the Ohio River near Louisville, and Lake Pokegama, Minn. The collecting of juvenile mussels in Lake Pepin indicated that the artificial propagation of the local species of mucket in that water is producing good results. Collecting done in the White River, Ark., yielded numbers of young niggerheads and yellow sandshells but no muckets.

The cost of mussel propagation in 1918 was considerably in excess of that in the previous year. The cost of glochidia planted was \$0.0536 per thousand, as compared with \$0.373 per thousand in 1917. The increased cost of equipment, material, and labor contributed largely to the increased expense of the propagation work. This computed cost of propagation includes salaries of permanent employees actually engaged, overhead charges, and depreciation of \$0.004 per thousand. The overhead charges include one-third the director's salary; one-half the superintendent's salary, and one-half the clerk's salary.

The experimental propagation of mussels at the Fairport station was continued. Especially gratifying results were obtained in one pond, from which a total of 1,391 young of the Lake Pepin mucket were obtained when drained October 8 to 16, 1917. These mussels were the result of plants in the preceding season from fish held in open-bottom crates over an especially prepared bottom of sand. They varied considerably in size, measuring from about 1 inch to 2½ inches in length, indicating that they resulted from several plants. These results are especially important, as this is by far the largest number of mussels ever reared under artificial conditions at one time. Fish infected with this mucket had also been placed in crates in two other ponds in the spring of 1917, and when these were drained in the fall 382 mussels were recovered. Specimens resulting from a plant made in 1914 continued to grow in the station ponds, and by October, 1917, some had reached a length of more than 3½ inches.

**MUSSEL PROPAGATION, FISCAL YEAR ENDED JUNE 30, 1918—POINTS OF DEPOSIT
AND SPECIES OF GLOCHIDIA PLANTED.**

Species.	Fairport, Pokegama	Fairport, Mississippi River.	New Bos- ton, Mis- sissippi River.	Lake Pepin.	Black River.
Yellow sandshell (<i>Lampsilis anodontoides</i>)		3,547,900	4,548,000		
Mucket (<i>Lampsilis ligamentina</i>)		11,758,850	26,667,400		19,226,500
Butterfly (<i>Plagiola securis</i>)		38,800			
Lake Pepin mucket (<i>Lampsilis rutcola</i>)	30,417,700	65,000		91,226,500	
Total	30,417,700	15,410,550	31,235,400	91,226,500	19,226,500

Species.	White River.	Cumber- land River.	Lake Keokuk.	Ohio River	Total
Yellow sandshell (<i>Lampsilis anodontoides</i>) ..	11,000	15,500	149,200		1,271,000
Mucket (<i>Lampsilis ligamentina</i>)	1,797,000	2,338,500	248,000	5,425,100	68,061,350
Butterfly (<i>Plagiola securis</i>)	518,000		34,000		580,800
Lake Pepin mucket (<i>Lampsilis rutcola</i>)			9,707,100		131,416,000
Black sandshell (<i>Lampsilis recta</i>)	115,325		22,500		137,825
Pocketbook (<i>Lampsilis ventricosa</i>)	664,650				664,650
Total	3,105,975	2,354,000	10,160,500	5,425,100	209,132,825

**INVESTIGATIONS AND EXPERIMENTS REGARDING AQUATIC
PRODUCTS.**

MODIFICATION OF THE SCIENTIFIC WORK.

The conditions of war have necessarily led to marked modifications of the Bureau's general plan of scientific work. Efforts have been devoted primarily to such studies or practical experiments as could be expected to contribute promptly to the increase of the supply of food or other useful aquatic products, but there has been no exclusion of biological and chemical investigations which have to do chiefly with our preparation for meeting the problems that will confront the Nation after the war. An outline of the scope of the chief investigations and other work appropriately associated with the scientific inquiries, and in some cases the actual results obtained, are briefly summarized.

EXPERIMENTS RELATING TO THE PRESERVATION OF FISHERY PRODUCTS.

An important phase of the Bureau's scientific work is the solving of problems in the preservation of fishes for food. No more useful service for the prevention of waste and the promotion of the use of aquatic foods can be rendered than by ascertaining the conditions leading to spoilage of fresh and cured fish and by discovering more effective methods of preservation. Especially is it important to find means of treatment or of preservation which are suited to the fishes that can not be adequately utilized by old methods or are adapted to climatic or transportation conditions under which the common means of preservation fail of their purpose.

Principal among investigations of this character are the experiments in the preservation of fresh fishes by methods of desiccation.

Similar modes of preservation have established their efficiency for the preservation of vegetables both in the home and in the industries. Dried salt fish are well known in the market, but under the climatic conditions prevailing in the United States the sun-drying of fresh fish has not proved commercially feasible.

Drying of fresh fish.—Working in the Woods Hole laboratory during the summer of 1917 an investigator conducted experiments in drying various species of fresh fish and squid. Domestic fruit driers, steam-heated fish driers, driers with air heated by means other than steam, driers which force air over the fish at varying temperature, and the methods and limitations of sun-drying were tried.

Several species of fish, including cod, haddock, and whiting, have been successfully prepared for commerce by preliminary steaming, picking the meat from the bones and skin, passing through a meat chopper, and drying in commercial fish driers. Further experiments may lead to improvements of methods from the viewpoints of economy in production and appearance of the product. Experiments in rehydration of the dried product have also been conducted.

Methods of desiccation have obvious advantages over other methods of preservation in the saving of storage space, in economy of transportation, and in the indefinite preservation of the product without continuous expense. It is also true in some cases, at least, that there is much less waste of soluble nutritive substances, and that the natural flavors may be better maintained.

The results in the case of squid are noteworthy. Squid, in the drying process, is reduced to broad, thin sheets of inviting appearance which may be chopped to form chowder or soup stock. There is a characteristic and particularly agreeable flavor which, together with the very high protein content, promises much for the eventual addition of the squid to the American dietary. Subsequent experiments have shown that the tenderness of the product is much improved by steam cooking before the squid is dried. While squid can be conveniently canned, the process of canning fails to preserve the characteristic flavor so well as the method of desiccation. The palatability of the squid has been so thoroughly tested by people of many Asiatic and European countries that one must consider the lack of acquaintance with it as the only bar to its use by Americans. Important facts of practical value that have now been definitely determined are: (1) The toughness of the meat is overcome by methods of steam cooking and drying, after which the squid can be kept for an indefinite period without deterioration; (2) the excellent flavor and delicate aroma are not lost by the methods of drying or by subsequent cooking by proper methods, such as by boiling over a hot fire or by stewing for a short time in a small amount of hot water and serving in the juice in which it was cooked.

Bacteriology of preserved fish.—In the field of bacteriology, investigations have been directed first at determining if bacteria play an important part in the initial stages of decomposition of fish during storage in ice. Freshly caught fish of several types were stored in ice boxes similar to those in use in the average fish market, and at regular intervals some were removed and the muscle tissue was subjected to bacteriological examinations to determine the number of aerobic bacteria present that would develop at 22° and 37° C. in both

plain and fish agar. The following conclusions were drawn from the experiments: (1) Fresh muscle tissue is practically sterile; (2) drawn fish show more bacteria than undrawn fish as the period of storage in ice progresses and in a shorter time; (3) undrawn fish stored for a period of two or three weeks in ice and totally unfit for food showed relatively few bacteria; (4) autolysis seems to play a more important part than bacteria in the initial stages of the decomposition of fish stored in ice.

Further studies relate to organisms which cause the "reddening" of salt fish, especially of the cod, a condition which detracts from the appearance of the fish, diminishes the market value of the product, and causes serious economic waste. After a period of preliminary studies in the laboratory during the early part of the year, it was determined to transfer the work to the seat of industrial operations at a principal fishing port. The conditions determining the prevalence of this infection, for such it is, are now pretty well understood, and it is believed that the solution of the problem of preventing the infection is about to be realized.

Miscellaneous investigations of problems of preservation.—Other scientific investigations of immediately practical application have related to the salting and smoking of shark meat, the utilization of grayfish eggs through the preparation of a soluble acid albumen, the extraction of the oil from grayfish eggs, the preparation of gelatin from the heads, fins, and tails of the grayfish, and the relation of ammonia production in the grayfish to the corroding of tin. The alleged toxic qualities of the roe of the garfish have been studied both from chemical and physiological points of view, and some experiments have been made to determine the origin of a certain objectionable flavor which is said to characterize caviar prepared from the roe of the carp. None of these investigations has as yet reached a point justifying the publication of results.

The more directly scientific investigations have been supplemented by practical trials of the preservation of fish in various ways, and in some cases important results have been obtained in the application of old methods to new fishes. The demonstrations associated with such trials have been productive of much good, not only through instruction of fishermen in the use of approved methods of preservation which were previously unknown or unused in certain localities, but, as well, through the education of fishermen with reference to the value of extreme care in the adaptation of commercial methods to the particular species of fish, to the local or seasonal conditions, and to the demands of the market which it is intended to supply.

The scientific assistants in the regular employ of the Bureau and the specialists from without who have associated themselves temporarily with the Government fisheries service have taken an active and effective part in the work of propaganda or public education in the more general and more intelligent use of fish as food. In such work these men of science render a particularly valuable service, because they can speak or write without bias and with a knowledge of the nutritive value of fish food and its appropriate place in the diet. The Bureau has had ample evidence that the public generally has appreciated such service and that it has responded in a practical way to the counsel which has been offered.

Although culinary demonstrations are not strictly a part of the scientific inquiries, nevertheless it has been found impossible to dissociate them from the work of investigation. In some cases skilled cooks have been engaged in association with the investigators or independently, and demonstrations have been given at State or county fairs, before women's organizations, or men's clubs, or in open meetings, whenever the public could be most effectively reached. In this way it has been possible to bridge completely and promptly the common gap between the discovery of useful facts and the final practical application in the individual household of the knowledge gained. In such public services the Bureau has been enabled to cooperate with various bureaus of the Department of Agriculture, notably with the States Relations Service and with the United States Food Administration.

The lack of vessels for offshore investigations has made it impossible to make explorations of oceanic fishing grounds. Reference may be made, however, to an investigation of an alleged waste of fishes on the coast of Cape Cod. It was learned that certain kinds of fishes, especially the whiting, were being taken in the trap nets in quantities far in excess of the capacities of the cold-storage plants, as well as of the market demand for fresh fish of these kinds. The Bureau, therefore, took steps with some success to encourage the preservation of such fishes and to stimulate a public demand for the prepared product.

INVESTIGATIONS RELATING TO SOURCES OF SUPPLY.

The carp has long been the most important commercial fish living exclusively in fresh waters. There has been a good demand for carp in the principal cities, and, because of the increased demand for fish which has developed during the recent food shortage, the prices of carp have risen to relatively high figures. Nearly all of the carp for market have been shipped from a few States in the Middle West. Nevertheless, carp is known to occur in abundance over a large part of the country. In many waters carp has only a relative abundance and could not be counted on as a source of supply for commercial fishery. Nevertheless, these small supplies in the aggregate constitute a considerable quantity of food, and, if they were more generally used in local markets, a substantial reduction would result in the quantity of other foods it would be necessary to import into the several communities.

It is commonly recognized that when prepared in an offhand manner the carp makes a table dish of inferior quality. It is not so generally known that when properly prepared and served the carp takes a very favorable rank among other food fishes. In the effort to popularize this fish, the Bureau has prepared and published an economic circular giving an account of the food value of the carp, with recipes for its proper preparation. Effective posters were also given wide distribution directing attention to this neglected resource and bearing information that the circulars could be had on application to the Bureau.

Believing that there were supplies of carp in some of the southern States sufficient to support a commercial fishery, the Bureau under-

took a special investigation of the subject in the waters of South Carolina as typical of the conditions in several southern States. The survey covered a period of several months and involved many experiments or fishing trials intended to determine the proper sorts of gear to use under the varying local conditions. The results of the survey may be summarized as follows:

The "upstate" waters will support only limited commercial fisheries and the output of these may be consumed locally; much local interest was found among farmers and others who possessed some sort of equipment for catching fish which they were unable to use because of the severe legal restrictions upon the fishery. The larger rivers, especially in their lower courses, offer favorable opportunities for the development of larger commercial fisheries. It is probable that fishing for carp in rivers near the coast for shipment to northern markets will prove distinctly profitable, especially if, as expected, the carp can be taken successfully during the winter months, when the conditions for transportation are at the best and the market prices are most attractive. Local fishermen witnessed and participated in the fishing trials.

An incidental result of the experiments and the inquiries associated therewith was the preparation of a paper treating of the methods of capturing carp commercially under different conditions. The information thus furnished will be applicable in all parts of the country where unutilized carp resources exist.

Other investigations have been directed toward locating beds of sea mussels on the North Atlantic coast which will support a commercial fishery of importance, and toward completing surveys of the sea-mussel resources of the coast of California and the shellfish resources of the northwest coast.

EXPERIMENTAL FISH CULTURE.

The investigations and experiments conducted at the fisheries biological station at Fairport, Iowa, and directed toward the establishment of a more scientific foundation for fish culture in ponds, have continued to yield interesting and useful results. Both the buffalofish and the channel catfish have again responded satisfactorily to the attempts at propagation in ponds.

A comprehensive study has been made of the abundance, life history, habits, and importance of many species of dragon-flies and damsel-flies in fish ponds. In their relation to fish it is learned that while the larvæ feed to some extent upon the same kinds of food as some fishes, they also subsist to a considerable degree upon animals that are directly harmful to fish; and while, under stress of hunger, they occasionally eat small fishes, they themselves afford an abundant food supply for fish. Although the nonaquatic adults sometimes prey upon beneficial insects, the larger part of their subsistence comprises positively injurious insects. The dragon-flies and damsel-flies have a distinct economic importance in their effect upon the balance of life both within and without the ponds.

Studies of aquatic plants in relation to fish culture are making satisfactory progress and are contributing to the desired fund of knowledge regarding the utility of both the higher and the lower

forms of plant life. Such investigations are of fundamental importance because all food of fish is provided through the medium of plants. There can be no fish or animal life except as the inorganic materials are converted by green plants into materials that are suitable for the food of animals. Fish are thus dependent upon plant life whether they forage directly upon the plants or subsist upon smaller animals that derive their food directly or indirectly from the vegetation. But some plants are more useful than others, and some are undoubtedly injurious in their effects upon ponds. It is necessary, therefore, that previous knowledge be obtained regarding the biological and economic relations of the various forms of plant life within the fish pond.

A significant anatomical study of the salmon, conducted principally in the Washington laboratory, has brought to light previously unrecognized facts regarding the structure of the reproductive organs and the normal manner of extrusion of the eggs. These facts are found to have a direct bearing upon fish-cultural practices, and they dictate the necessity for certain changes in method and for extreme care in the handling and stripping of spawning trout and eastern salmon in order that the loss of eggs and permanent injury to the breeding fish may be avoided.

Reference may be made to an investigation of the possibility of utilizing the abandoned rice fields of South Carolina and Georgia for the culture of carp on a commercial scale.

INVESTIGATIONS AND PRACTICAL WORK IN ANTIMALARIAL CAMPAIGNS.

With the measures which are generally relied upon for the control of the abundance of mosquitoes and the eradication of malaria, this Bureau has no direct concern. They lie within the domain of sanitation and entomology. It may be said, however, that it has become very clear to all concerned that under many conditions the direct methods of sanitary science generally employed in combating the mosquito, whether physical, chemical, or engineering, either are not practicable of application, or else, when applied, fail of accomplishing the desired purpose. It has been found necessary in many cases to rely to a great extent upon nature's method of controlling the abundance of organisms through their competitors and enemies. It is well known, however, that nature's control of the abundance of mosquitoes, as of other animals and plants generally, is relative and not absolute. The problem in this case is to find means of making the enemies of mosquito larvæ dominant over their natural prey, of making them efficient in the extermination of the larvæ of anophelid mosquitoes at least.

The problem is primarily within the domain of aquatic biology and concerns especially the small mosquito-eating fishes and other associates; and in this problem, in its phases both of investigation and of practical work, the assistance of the Bureau of Fisheries has been solicited by the Bureau of Entomology and the Public Health Service.

The cooperation with the Public Health Service has been principally in the urgent task of protecting the health of soldiers in one of the large southern cantonments. The plan of work comprised

the use of all available means of protecting and increasing the supply of top minnows (*Gambusia*) in the area under protection, and the careful observation of the effectiveness of these and other fishes in the extermination of mosquito larvæ. To increase the number of minnows in the extra-cantonment area, propagation was resorted to and fish were also brought in from places outside of the protected area. As the top minnows were found to be a favorite live bait in angling, the cooperation of the public was sought and received through the use of posters, placed at or near the various small ponds, bearing a warning that the small fish were given protection as a health measure.

It has been fully demonstrated that the small fishes are in many cases most effective agents for the control of mosquitoes, but it has also been positively ascertained that the efficiency of fish even when present in abundance is by no means universal and complete. Much depends upon the physical and biological conditions in the water, such as the presence of débris and of plants of various species, wave action, fluctuations of level, and various other factors. There is, as yet, lacking the degree of knowledge necessary to define fully the conditions under which fish are effective, or to govern the change of conditions so as to make the fish as efficient as is desired. It is with reference to securing a sure foundation of knowledge concerning the relations of fish and mosquito larvæ that the campaign of observation and experiment in cooperation with the Bureau of Entomology was undertaken two years ago at Mound, La., as mentioned in previous reports. The investigations at Mound have been continued actively and bid fair to make substantial contributions to knowledge which will be of direct and decisive importance in the future conduct of antimalarial campaigns.

DISEASES AND PARASITES OF FISHES.

The Bureau has given special attention to the diseases of fishes as bearing upon the loss of fish in hatcheries, fish ponds, and public waters. While the subject is broad and the problems arising are difficult and tedious of solution, substantial progress has, nevertheless, been made during the year in the study of some of the affections to which fish are subjected in artificial and natural bodies of water.

A new parasite of the buffalofish.—An investigator of the Fisheries Biological Station at Fairport, Iowa, has discovered a new and evidently important form of trematode worm which infests buffalofish in ponds. The life history of the parasite has been definitely worked out and is briefly as follows:

The adult trematode, living in the alimentary tract of the buffalofish, expels its eggs, which pass out into the water. From each of these eggs, which are "laid" during the late summer, there hatches in the fall a ciliated embryo (mericidium), which swims in the water until it finds a snail of the species *Planorbis trivolvis*. Into this snail it works its way and eventually encysts in its host's liver. In the usual manner it grows and multiplies there during the winter and spring, and in summer emerges from the snail as a tailed and styleted cercaria. This larva can live for several hours in the water, but must find a May fly larva for its second intermediate host, into which

it bores and encysts just beneath the cuticle. If the buffalofish eats the infested larva it obtains the young parasite, which very rapidly develops and assumes in the late summer the adult form ready to expel its eggs. The association of the buffalofish, the snail, and the May fly larva seems to be essential for the perpetuation of the parasite. The probable importance of the form is suggested by the fact that a serious mortality occurred among the fishes that were so infested.

The life history of a trematode parasite of the bluegill sunfish was also investigated. It is found in the larval stage in that fish and in the adult stage in the kingfisher.

Investigation of protozoan parasites.—Investigations of protozoan parasites at the Bureau's station at Fairport, Iowa, during the summers of 1916 and 1917 produced interesting results which promise to be of practical value to fish culture. The myxosporidia are quite common on fish from the Mississippi River, and evidence seems to prove that they are to a degree seasonal in occurrence. Under certain conditions they may cause serious injury to the host, but in the case of the buffalofish, and possibly of other species, it is believed that danger from infection in ponds might be lessened by a proper rotation of the fish in a series of ponds, as the young seem to become infected from the adults placed in the same pond to spawn.

A hitherto undescribed species of coccidia is believed to have caused the death of young carp after transference from one of the ponds to hatchery troughs, as an exceptionally heavy infection of the intestines with these parasites was associated with a serious degree of mortality. Although infection of the pond fish with the ciliate parasites *Ichthyophthirius*, *Chilodon*, and *Cyclochaeta* was quite common, a much heavier infection after transference of the fish from the ponds to the tank house, probably induced by change of environment, would seem to indicate that these parasites have been largely responsible for the previous heavy mortality of the fish in the tanks.

Peculiar disease in brook trout.—At a commercial hatchery in Rhode Island a peculiar disease of brook trout caused the loss of a large number of fish. The diseased fish at first became apathetic, then turned black and became blind. Just before death the fish would dart jerkily through the water for a time, losing equilibrium toward the last. As the result of the experiments conducted under the guidance of the fish pathologist of the Bureau, the cause of this unusual affection of trout was traced to the nonoil substances in linseed meal, the latter being a constituent of the food then used at this hatchery. The harmful effects of the linseed meal are believed to be due to action of a cyanogenetic glucoside or its decomposition products, though the actual proof will require further experimentation.

Miscellaneous studies of disease and parasites.—During the year a serious condition of diminished vitality and disease of the blue pike was reported from several points on Lake Erie. Specimens of fish received from Cleveland, Ohio, were found to be unusually heavily infected with a species of parasitic copepod (identified as *Ergasilus centrarchidarum*), which is known to occur abundantly on perch, sunfish, and bass, but is not generally found in numbers on blue pike and saugers. The fact of the peculiar abundance of parasites

on this particular species was held to indicate that some other condition had diminished the powers of resistance of the fish and made them an easier prey to parasites. There was some evidence of malnutrition and internal disorders, but investigation in the limited time available failed to reveal the original cause of the trouble.

A systematic examination of the parasites of fishes in Oneida Lake, N. Y., was made in cooperation with the biological department of the New York School of Forestry, but the study of the material obtained has not yet been completed. Further comprehensive study of the internal parasites of marine fishes was made in connection with the Woods Hole, Mass., laboratory.

Visits by the fish pathologist of the Bureau were made to various Government and commercial hatcheries for the purpose of inquiring into the cause of mortality and of offering suggestions for the prevention of loss by disease.

MISCELLANEOUS INVESTIGATIONS.

While the scientific work has been restricted generally to matters relating to the winning of the war, the Bureau has, nevertheless, continued several investigations which are of great ultimate importance and could not be interrupted without unwarranted sacrifice. Some of these investigations that have not reached a stage for report may be mentioned as follows: The intimate study of the habits and propagation of salmon of Pacific waters; problems of the oyster industry; the properties of the roe of certain fishes alleged to be toxic or distasteful; systematic relations, habits, and migrations of salmonoid fishes in the Great Lakes; the utilization of marine algæ; biological and physical conditions of fish life in inclosed waters; the distribution and habits of pelagic fishes off southern California. Among others the following may be cited:

Nature of "fat" oysters.—Technical studies have shown conclusively that so-called "fat" oysters are rich, not in fats, but in glycogen, a carbohydrate food. The processes of "fattening" must, then, be based upon conditions favoring glycogen formation. The place of oysters in the dietary is not just the same as that of meats and fish, which are eaten for their protein and fat content. Oysters furnish protein, but little fat, and, if they are in prime condition, they also furnish a significant amount of carbohydrate material, such as is usually made up by the cereal and vegetable elements of the dietary.

Protection of wood against marine borers.—The experiments and studies on this subject, which have been conducted in cooperation with the Forest Products Laboratory at Madison, Wis., and the Bureau of Forestry, have been practically completed as regards the use of creosote oils. Some of the results have been published independently by the investigators. Since the conclusions will be useful to all those who are directly concerned with the use of wood in the waters of warmer latitudes, they may be summarized in the words of the investigators, as follows:

1. The toxicity of creosote fractions decreases as the boiling point rises; that is, the creosote and its distillates, arranged in the order of decreasing toxicities, are: Fraction I, fraction II, creosote, fraction III, fraction IV, fraction V. The high toxicity of fraction II,

which is solid with naphthalene, was probably due mainly to tar acids.

2. The creosote light oils are definitely poisonous for the borers. Benzol is the most and xylol is the least toxic. The toxicity of toluol lies between these two.

3. The tar acids are all highly poisonous to the borers. Their toxicity steadily increases with rise in molecular weight; that is, arranged in order of increasing toxicity, they are: Phenol, the cresols, and the naphthols. The three isomeric cresols, which exert practically the same degree of toxic action, are about twice as poisonous as carbolic acid; while the two naphthols, also equally toxic, are 10 or more times as poisonous as phenol.

4. Tar-base fractions all show a high toxicity for the borers, and this toxicity increases with rise of boiling point of the fractions. Pure quinoline, boiling at 239° C., is several times as poisonous as pyridine, with a boiling point of 115° C. The toxicities of the tar bases are fairly comparable with those of tar acids of approximately the same boiling points.

5. In comparison with the tar acids or bases or even the lighter hydrocarbon oils, the solid hydrocarbons of creosote are only very slightly toxic. Arranged in the order of decreasing effectiveness, they are naphthalene, phenanthrene, acenaphthene, and anthracene. Naphthalene is perhaps five times as toxic as anthracene.

It has apparently been assumed that the more poisonous a creosote oil is the more effectively will it prevent attacks of marine borers. It will be noted, however, that the conclusions drawn from these direct toxicity tests, especially with reference to creosote and its fractionates, are diametrically opposed to the conclusions drawn from the service tests above; that is, the highest boiling fraction, which was the least poisonous, stood up the best in actual service. It has been pointed out that the principal object is to prevent an original attack of the larval shipworm when it is of but microscopic size. Heavy treatments with a proper type of creosote will still prove inadequate as long as areas of superficially treated sapwood, heartwood, knots, etc., are left exposed for the lodgment of shipworm larvæ.

The investigators conclude that a proper creosote oil for marine work should contain a large proportion of constituents boiling above 320° C., as well as considerable amounts of high-boiling tar acids and bases.

Marine algæ of the Pacific Coast.—Through the cooperation of a specialist from the University of California, marine algæ have been collected on the Pacific Coast from Grays Harbor, Wash., to Sitka, Alaska. Many new forms were discovered and the range of species previously known was extended. Of about 875 species previously reported on the Pacific Coast of North America from Mexico to Bering Sea about half are now represented in a collection prepared for the Bureau which will be deposited in the National Museum.

Interest in the marine algæ arises from the intimate relations existing between them and the fishes and shellfishes; from the significance of marine plants as ultimate sources of organic material in the sea, and thus as an indirect source of food for fishes; and from the fact that the algæ are resources useful in some cases for human food and in others as the basic material for potash, iodine, gelatin,

and other products useful in the arts and industries. The marine algae, although the use of certain groups has recently been greatly increased, may in general be regarded as neglected resources in the United States.

WORK AT THE FISHERIES LABORATORIES.

The use of the marine laboratories at Beaufort, N. C., and Woods Hole, Mass., for naval purposes has necessarily restricted the work of the Bureau thereat. During the early part of the fiscal year, before the Beaufort station had been turned over to the Navy, the laboratory served as a base for practical experiments in the preservation of fish by methods of salting and smoking, and for propaganda both among fishermen of the near-by coast and among consumers in the interior of the State, directed at better utilization of the local fish supply for food.

At this station also there was completed early in the year the field work of the investigation pertaining to the use of creosote oils for the protection of wood against marine borers, the results of which are referred to elsewhere. The Bureau has now entirely discontinued its operations at this place, with the exception of experiments in perfecting the culture of the diamond-back terrapin.

The Woods Hole, Mass., laboratory was employed during the early part of the fiscal year for experiments and investigations relating to the preparation of fish and bacteriological studies of fish tissues. Further attention was given also to the nutrition of oysters, the parasites of fishes, and the food of young fishes in local waters.

At the marine station at Key West, Fla., two buildings of small size have been constructed, one affording necessary living accommodations for some of the employees, and another space for the pumping equipment and for a provisional laboratory. These, with the canal and pool for water supply largely completed during this and the preceding year, are regarded as among the most essential requirements for the effective prosecution of work. The difficulties of obtaining labor and materials and the very high prices prevailing have made it unavoidable that progress in construction should be slow. Under the present conditions and with the limited funds available, further constructions are not contemplated. In spite of the inadequate equipment, an effective beginning of the scientific work of this station has been made. Useful information has been gathered regarding the fishes of the region, and the studies and experiments with the spiny lobster have yielded information that is interesting and promising of practical usefulness.

At the Fairport, Iowa, laboratory the investigation of mussel problems and the various studies relating to fish-cultural work, elsewhere referred to, were continued with satisfactory progress. The results of mussel propagation are given in another place. The Bureau suffered a severe loss at this station through the accidental destruction by fire of the main laboratory building in the early morning of December 20, 1917. Besides the building there were lost a library which, though small, had been assembled with much care, and valuable scientific records and natural history specimens. Fortunately the water-supply system and the smaller buildings remained unharmed, so that many phases of the important work of the station

could be continued without interruption. Congress has provided an appropriation for the erection of a fireproof building to replace the original building, which was of frame construction. At the close of the fiscal year plans for the new laboratory were nearing completion.

RELATIONS WITH THE FISHING INDUSTRIES.

INCREASING THE CONSUMPTION OF AQUATIC FOODS.

It is possible to record more active and effective work than in any previous year in making the American people better acquainted with the merits and availability of our aquatic resources as food and in pointing out sources of supply. This work has assumed a wide scope and many phases, but the primal effort and purpose have been to increase public reliance on such resources as staple articles of food, to dissipate unwarranted prejudices, and to cause the discontinuance of wasteful practices in the utilization of water products.

The Bureau is fully cognizant of the important service it can and should render the fishing industries, by determining and making known the suitability of many of our fishes to new and untried methods of preservation; by sending trained experts to the fishing centers to give instruction in those methods which prove meritorious; by improving methods in common practice and discouraging the use of unsatisfactory methods; by introducing into our fisheries useful foreign methods and processes; by increasing the use of the little-used or neglected fishes and fishery products; by developing methods of preparation and new uses for the waste products of the fisheries; by furnishing to fishermen and others practical advice relative to special equipment required for new methods and processes that may be in contemplation; and by contributing by all available means to the upbuilding of the fisheries, while at the same time safeguarding these resources from possible depletion or exhaustion.

During the past year the demands on the fishing resources of the country have been of such magnitude that the Bureau has found an unprecedented opportunity for rendering service in the field of endeavor before outlined. It has devoted all possible energies to the solution of those problems which promised the largest and most immediate results, and has diverted men and funds to work of this character in so far as it was possible so to do. The small available force of trained assistants has been the principal factor in limiting the activities. The meager funds allowed by Congress for this work have been supplemented by the special allotment elsewhere referred to.

Aid has been rendered in developing markets for such inadequately used or partly neglected fishes as the herring of Alaska, bowfin, burbot, carp, crevalles, drum, elops, eulachon, grayfish, gizzard shad, jewfish, menhaden, rays, redfish, river herrings, robalo, rockfishes, sablefish, sea catfishes, sea robins, sharks, skates, tarpon, and tilefish; such aquatic mammals as dolphins, porpoises, and whales; and such neglected food products as fish roe and milt. For some species the Bureau has developed new and suitable methods of preservation, discouraged the practice of unprofitable methods, and assisted in solving difficulties which were obstructive to the full use of the product.

One of the agents has devoted his entire time to a study of practical problems of the west-coast fisheries. This work has been pro-

ductive of much good, and has enabled the Bureau to render more effective service in this field. Another of its agents has been conducting a campaign of education in the Middle West as to the merits of the South Atlantic and Gulf coast fishes which can be supplied in large quantities. In cooperation with other Government agencies, the Bureau has been instrumental in bringing Gulf coast fishes into Tennessee, Kentucky, and Indiana in carload lots at a time when it was difficult to obtain in that region satisfactory supplies of fresh fish at reasonable cost. Within two months of the inauguration of this service, about 200,000 pounds of fish were shipped and plans are being perfected for the extension of this kind of service to other sections.

In order to bring newly introduced fishes or other products to the attention of the consuming public, it is necessary to conduct a systematic and well-sustained advertising campaign. By the issuance and wide distribution of posters and placards devoted to particular fishes, by having the newer products tested by workers skilled in cookery to determine the best methods of preparation for the table, and by the printing, in inexpensive form, of cook books embodying the results of tests, the Bureau has been able to interest a large number of people in the merits of water products with which they were not previously acquainted. A still more direct appeal to the public has been the employment of well-qualified demonstrators for the purpose of educating housewives in fish cookery, teaching them to recognize the qualities of each kind of fish and prepare it in the manner best suited to its character, and showing how to utilize heads, bones, and other waste parts for savory sauces, soups, and chowders. On the Pacific coast the demonstrations have been exceedingly popular and well patronized, and local fish dealers report much larger sales of cheaper fish in consequence of this work. Plans are being perfected for the extension of this service to other parts of the country.

It has, as yet, been possible to form no reliable estimate of the actual results of the campaigns for the introduction of bowfin, drum, eulachon, menhaden, sharks, roe and buckroe, mussels, etc.; but, on the basis of fresh weight, it is known that upward of 32,500,000 pounds of burbot, grayfish, sablefish, tilefish, whiting, and Scotch-cured Alaska herring were marketed in 1917, and most of this quantity can be attributed to the recent activities of the Bureau.

Among the products in whose behalf there were special activities the following may be mentioned:

Fish roe and buckroe.—The eggs of such fishes as the sturgeon and spoonbill catfish, or paddlefish, are made into caviar, which is classed among the most valuable of our fishery products. The roes of various others, such as cod, haddock, mullet, river herring, shad, and whitefish, are quite extensively used for food, either fresh, salted, or canned. On the other hand, large quantities of roe, and practically all of the buckroe or milt of marketed fishes, are wasted. These are essentially nitrogenous foods, with a considerable quantity of fat, and differ in composition but little from the flesh of the fish. They do, however, contain a larger quantity of an important constituent of food, organic phosphorous, in the form of lecithin. The buckroe, or milt roe, of the male, which corresponds to the egg mass of the female

and is sometimes called soft roe, as shown by analysis, compares favorably in food value with the roe and flesh of the fish. This is an excellent product, a delicate and palatable food, which lends itself to preparation in all the ways in which sweetbreads and brains are served. These products may be used fresh or canned.

The Bureau has encouraged fishermen to pack these products, has aided in the marketing of such stocks as have been accumulated, and is educating the public to their merits. In addition to the usual packs of roe of various fishes, small quantities of the buckroe of the river herring, sea herring, and cod have been put up and preparations have been made for the pack of the buckroe of other species in season. Now that the packers are beginning to appreciate the quality of the product and the fact that it can be marketed, it is believed that much larger packs will be put up in the future.

River herring or alewives.—The fishery for these species is of great importance in the Chesapeake Bay region and the sounds of North Carolina. The Bureau has given considerable attention to the development of much-needed improvements in the methods of handling and preservation of the catch, and has emphasized the importance of the packers adopting these measures. Experiments in Scotch curing indicated that these fish, preserved in this manner, will not yield a high-grade product. They may be preserved as Russian sardines, but are slightly inferior to the sea herring because of their larger size and lower fat content. Some of the fish were experimentally canned in tomato sauce, mustard sauce, and vinegar. The addition of the tomato sauce greatly improves the quality of the fish, and, if the packers will overcome the present difficulty of shrinkage in the can and process the fish carefully with the addition of the sauce, it is the consensus of opinion that a product of high quality, acceptable to the trade, can be produced. Fish soured in brine made of vinegar, salt, and sugar, in the proportion of about 18 pounds of salt, 6 pounds of sugar, and 8 quarts of pure grain spirit vinegar to 24 quarts of water, then smoked lightly and canned were very palatable. Because of the added expense and labor, it may not be practicable to pack the fish by this method for market. It is unfortunate that not all of the packers appreciate the importance of packing only sound fish, under sanitary conditions, which must be done if the fishery is to continue to thrive.

Menhaden.—The menhaden is one of the most abundant species in our Atlantic coastal waters. It has been used almost solely for conversion into fish oil and fertilizer, and the catch for this purpose has in a single year amounted to over 1,000,000,000 fish, weighing more than 635,000,000 pounds. The possibilities of this fish as a material factor in our food supply are obvious. Small quantities of fresh menhaden are eaten by the fishermen and small numbers are sometimes included with shipments of miscellaneous fresh fish to our larger cities. The number marketed in this manner is increasing. In New York City during September, 1917, 29,638 pounds of the fresh fish were marketed, and in October, 33,379 pounds. Considerable quantities were marketed in Washington City in the autumn of 1917, as many as 50 barrels (about 10,000 pounds) having been sold at the wharves in one day. During the fall fishing for menhaden in the Chesapeake Bay region, each fisherman on the menhaden boats

is privileged to salt for winter use a barrel of select menhaden and many of the fishermen avail themselves of this privilege. Experiments conducted by the Bureau indicate that this fish can be rendered very palatable by salting and smoking, and also that it makes an acceptable canned food.

Sharks.—The value of sharks as food has been recognized in the countries bordering on the Mediterranean, in Great Britain, in Japan, and in many other countries. Until recently their use for food in the United States has been limited mainly to seafaring people in scattered localities, and to the markets of some of our larger cities, where they are not infrequently sold under the name of more highly valued fishes. The number of markets offering these fishes for sale is increasing, and more and more of the product is being sold for what it is.

The flesh is white, slightly gelatinous, and compares favorably in food value with other staple food fishes and meats. The flesh of the young and of the smaller varieties, such as the grayfish, common to our coastal waters, is very good fresh. The flesh of the larger sharks may be salted, smoked or kippered, salted and dried, flaked or shredded. Experiments conducted by the Bureau indicate that the product lends itself particularly to light salting and hot smoking, and the kippered product may be canned to advantage.

Results of private investigations reveal the presence of a large percentage of hydrocarbon oil in the liver oil of some sharks. This property or the presence of some alkaloid may account for the reputed unsuitability for food of the livers and of the flesh of some of the species occurring in Arctic waters. However, the flesh of practically all of the species taken on our coasts has been tried and pronounced suitable for human consumption; in fact, that of a number of species is spoken of highly as the equal of some of our choicest fishes.

Carp.—The carp is the most abundant, most widely distributed, and most valuable fish in the fresh waters of the United States. During a considerable part of the past year difficulty has been experienced in supplying the demand for this fish. With the increase in demand for it in those sections where its merits as a food fish are appreciated and with the inability of the regular fisheries to supply the demand, the need of developing additional fisheries has been felt. The Bureau has extended aid to various sections in widening the markets and studying the possibilities for establishing fisheries, and has encouraged the use of this fish by people who have been prejudiced against its use for food. Among the services performed may be mentioned that of establishing connections between producers seeking markets and the trade in the larger consuming centers.

A number of the States have also appreciated the importance of utilizing more of the carp and other less-esteemed species, such as the buffalofish and suckers, to relieve the food shortage in the present time of stress. Noteworthy among these are Wisconsin and Minnesota. During the period from September 1, 1917, to April 1, 1918, under the supervision of the State Conservation Commission of Wisconsin, 1,264,680 pounds of carp, buffalofish, and suckers were taken from the inland waters of that State. As an immediate result of the action of the Game and Fish Department of Minnesota in suspending regulations in so far as they apply to the capture of rough fish,

1,382,187 pounds of carp were taken and marketed between October 1, 1917, and February 1, 1918.

Drum.—The common drum is found on the coasts of the Middle Atlantic, South Atlantic and Gulf States, sometimes in very large schools. It is a bottom feeder, subsisting largely upon crustaceans and mollusks, and reaches a weight of about 150 pounds. Personal prejudice, because of the presence of muscle parasites in the posterior part of the back, has greatly restricted the use of this important food fish. On the other hand, some persons familiar with this condition consider the infested portion the most desirable part of the fish. While the fish may be marketed fresh or preserved in various ways, it is as a canned product that it is most appetizing. Prepared in this manner, it has been likened to the meat of chicken.

The Bureau has given considerable attention to the development of markets for this fish, but, because of the irregular movements of the schools, some difficulty has been encountered in obtaining steady sources of supply. It is expected, however, that this difficulty will be overcome and that larger quantities of this wholesome fish will be made available.

Whales and porpoises.—Whales and porpoises being mammals and their bodily activities being essentially the same as those of a cow, horse, or other land mammal, their flesh is "meat" rather than "fish." The meat of the whale resembles beef in texture and appearance, and, although by some it has been compared to venison in taste, it nevertheless has a distinctive flavor of its own. A sample of canned whale meat, analyzed by the Bureau, contained 30.11 per cent protein, 6.52 per cent fat, and 1.8 per cent ash. Of the whales, the humpback (*Megaptera nodosa*) is probably the best for food, but the sei whale (*Balaenoptera borealis*) and the finback (*Balaenoptera velifera*) also yield excellent meat. From a humpback whale about 6 tons of edible meat may be obtained, from the sei whale 5 tons, and from the finback 8 tons. The whales which are largely available for food subsist almost entirely on a small shrimp (*Euphausia*). In fact, none of these whales eat fish habitually and only do so at all when shrimp are not to be obtained.

Whale meat holds an important place in the dietary of the Japanese and is growing in favor in other countries. The Bureau has emphasized the importance of utilizing this product for food, and very satisfactory progress has been made in saving and marketing it. On the west coast one whaling company in August, 1917, completed a 25-ton cold-storage plant, with a sharp freezer to care for 50 tons, and during the season marketed over 80 tons of the fresh meat in American markets, principally in west-coast cities. Arrangements have been made for marketing 500 to 600 tons during the 1918 fishing season, and shipments are being made in carload lots as far east as Boston. A British Columbia plant also marketed a large amount of the fresh meat and was prepared to pack about 50,000 cases of the canned meat in 1918.

Porpoises and dolphins are excellent for food, by some preferred to the larger whales. The Bureau has been instrumental in bringing the value of these forms to the attention of fishermen on the Atlantic and Gulf coasts, and progress is being made in the establishment of

markets for the meat of these creatures. It appears that the oily taste, which may be more or less objectionable to some, can be avoided by removing the connective tissue which lies between the blubber and the meat.

UTILIZATION OF FISH WASTE AND WASTE FISH.

Twenty-five per cent or more of the original weight of fish is inedible. It is possible to convert this residue into products of high market value, and more of it should be so employed instead of being wasted. In the salmon fisheries of the Pacific coast alone it is estimated that the value of this material, if fully utilized, would amount to several million dollars annually. It is also possible to manufacture much of this refuse and such fishes as the menhaden into products having a high economic value. For example, the scrap made from menhaden may be converted into fish meal as a feed for hogs, poultry, and cattle, rather than into fertilizer with which to grow feeds. The best use man can make of fish is to eat it. In like fashion, the best use for fish scrap is to feed it to stock intended to supply the wants of man. By the employment of the animal manure as a fertilizer, it can be made to serve both purposes.

In the case of fish meal greater progress has been made abroad than in the United States. For a number of years before the war, the Germans not only used all they could produce but imported many thousand tons annually from Great Britain and Norway. Considering the costs of transportation, manufacture, and distribution, it is evident that the product was highly valued. Feeding experiments conducted abroad and in this country have demonstrated this value.

One cause that has militated against the use of this product has been the impression that the flesh of animals to which it is fed will become flavored thereby. This feeling is presumably due to the fact that the flesh of animals reared in fishing camps and villages and supplied with an excessive or unlimited diet of fish acquires a fishy taste. As a matter of fact, if the animals are fed intelligently on fish meal with a low oil content, no untoward effects will be experienced.

Fish meal may be prepared by the same general methods as are now employed in the manufacture of the scrap for fertilizer; that is, by steam cooking, pressing, and drying. In addition, it may be necessary to grind it for the purpose of breaking up such sharp spines and pointed bones as remain. It should be made from fresh raw material, under sanitary conditions, dried at a sufficiently low temperature to prevent scorching, and should contain preferably not more than 10 per cent of fat (oil). It is suggested that those employing hot-air driers use charcoal or anthracite and avoid the use of long-flaming fuels to prevent scorching. It should be evident that the higher the percentage of oil in the meal, the greater will be the care required in feeding it. As fish meal is a protein food, it is to the advantage of the producer to reduce the oil content to a minimum, and thus obtain a higher protein (ammonia) analysis. Furthermore, the oil has a higher value when sold as such than if left in the meal.

The higher grades of tankage, with a guaranteed protein content of 60 per cent, are used extensively for feeds, and command as much as \$100 per ton or more in carload lots. The supply of this material is inadequate. Experiments, conducted by the Department of Agriculture, indicate that fish meal is fully the equal of tankage as a feed. As to demand, it has been estimated that Nebraska alone can use 30,000 to 40,000 tons annually. In the United States, there are grown each year 60,000,000 or more hogs, each of which will require an average of not less than 50 pounds of a feed of this character. From the evidence at hand it would appear that satisfactory markets are assured.

On the west coast and in New England the production of fish meal is increasing. In 1917 the reported output in the Pacific Coast States and Alaska was 5,297 tons, an increase of more than 100 per cent over the previous year. Considering the demand and the importance of this product to the country, it is imperative that those engaged in the fisheries render all possible aid to meet the demand.

The subject of rendering fish oils suitable for edible purposes is also receiving more attention. In 1914 Denmark used 20,000 barrels of hardened whale fat in the margarin industry, and more recently Norway has been experimenting with this article and is preparing to employ it for the same purpose. It is reported that this product has been proved to be well suited for making margarin that keeps well and tastes well, and to be even better suited for making lard. Experiments are in progress in the United States with fish oils to determine the practicability of rendering these suitable for edible purposes and marketing them commercially.

The Bureau has continued its efforts to accomplish a more complete utilization of fish waste to the best possible advantage. The importance of doing this has been brought directly to the attention of those engaged in the industry, and many inquirers in this country and abroad have been furnished with data relative to methods, machinery, and markets. On the Atlantic seaboard the Bureau has interested menhaden companies in the production of fish meal. In this field it has had the cooperation of the Bureau of Animal Industry of the Department of Agriculture in bringing the use of this product to the attention of hog growers, in giving suggestions relative to preparing the product so that it will be acceptable for feeding purposes, and in arranging for additional feeding experiments at various agricultural experiment stations. Tangible results have already been obtained, and it is expected that ultimately this fishery will yield annually about 40,000 tons of this material. The Bureau's efforts to establish fisheries for grayfish and other species of sharks has been of benefit to the fish-oil industry in that those engaging in these fisheries have been interested to recover and market the liver oil.

HOME CANNING OF FISH.

Although the preservation of fish in the home by canning affords an excellent opportunity for the increased saving of fish, the housewife has made little use of this method. With the development of small pressure cookers, purchasable at reasonable cost, it is possible for the housewife to process fish in the home, duplicating the work

of the commercial canner. In this manner she may practice a measure of economy and provide a supply of palatable and nutritious food in seasons of the year when fish are abundant for use in periods of scarcity.

The primary object of "processing" fish, or cooking them under steam pressure, is to sterilize them to prevent spoiling. An additional advantage of the method is that if the heating is continued for a sufficient length of time, the organic matter in the bones is dissolved, leaving only a soft, friable, mineral matter that can be eaten along with the meat. With the bones thus softened the fish is much more acceptable as food. Thus, small bony fishes that would otherwise be useless, or fishes of small market value, may be saved, and the larger staple fishes made more attractive.

The time required to soften the bones of fishes varies with the species, the size of the fish, and the pressure and temperature employed. In domestic canning, unless the required time is known, time and fuel may be wasted by overcooking, or by insufficient cooking the bones may not be properly softened.

A recent journal article calls attention to the small amounts of calcium present in most of the common foods and presents a table showing that comparatively large amounts of the ordinary foods are required to yield four-tenths gram of calcium oxide per day, which is about one-half the daily requirement of the average adult. The bones of fish, properly softened as they are by domestic or commercial canning, render available an abundant amount of calcium in acceptable form, not encountered in such amounts in any other common food. In addition to this they supply phosphoric acid and other valuable minerals. It is, therefore, not only good housekeeping, but good dietetics, to can fish for home use.

The Bureau has conducted experiments to determine the time required to soften the bones of about 30 common marine and fresh-water fishes of different sizes. In the table which follows the time given is that determined experimentally for the sizes mentioned. It will be a simple matter to interpolate the time periods required to soften the bones of fishes of the same species but of sizes different from those represented. The term "softening," as here used, means the point in cooking when the small bones, ribs, etc., are soft, but when the large vertebræ are not yet sufficiently soft to be consumed along with the muscle. In some of the larger fishes whose large bones could scarcely be eaten, even if they were softened, it would appear to be a waste of time and fuel to carry them to the point of complete cooking, and in such cases it ought to be sufficient to soften the small bones and sterilize the contents of the can. For such a purpose the "softening" rather than the "soft" point may be used.

These experiments refer to fish cooked in Mason glass jars of quart size. The time periods are measured from the point when the given pressure and temperature are reached (at the top of the cooker) to the time when the heat is shut off. The heating-up and cooling-off periods of time are thus not included. The fish were salted, but no water was added. Samples of fish canned during the course of these experiments were kept six weeks at room temperature (about 68° F.) and were then incubated at 98° for 48 hours. All were sterile.

TIME REQUIRED TO SOFTEN THE BONES OF VARIOUS SPECIES OF FISH, 10 POUNDS PRESSURE, 240° F.

Species.	Weight.	Softening.	Soft.	Species.	Weight.	Softening.	Soft.
Black bass:	<i>Lbs.</i>	<i>Mins.</i>	<i>Mins.</i>	Lemon sole:	<i>Lbs.</i>	<i>Mins.</i>	<i>Mins.</i>
Large.....	5-6	100	120	Large.....	2-3 ^a	80	90
Small.....	1-1	100	110	Small.....	1-2	60	70
Bluefish:				Mackerel, medium.....	1-1 ^a	60	70
Large.....	6-9	90	100	Mackerel, Spanish, medium.....	1-2 ^a	100	110
Small.....	1-2	80	90	Perch, white, medium.....	1-2 ^a	100	110
Butterfish, medium.....	1-2 ^a	60	80	Perch, yellow, medium.....	1-2 ^a	90	100
Carp.....	8-12	110	120	Pollock, medium.....	5-7 ^a	60	70
Catfish:				Salmon, medium.....	13-19	90	100
Large.....	1-2	70	80	Sea bass, medium.....	1-1 ^a	60	70
Small.....	1-2 ^a	60	70	Shad.....	5 ^a	90	100
Cero, medium.....	10-13	80	90	Small:			
Cod:				Large.....	(a)	60	70
Large.....	6-16	80	90	Small.....	(b)	50	60
Small.....	1-2	50	60	Snapper, red:			
Croaker:				Large.....	10-15	110	120
Large.....	1-1	90	100	Small.....	5-6	90	100
Small.....	1-1 ^a	50	60	Squeteague:			
Eel.....	2-3^a	100	110	Large.....	2-4	80	90
Flounder:				Medium.....	2	60	70
Large.....	1-1 ^a	70	80	Small.....	1-2	50	60
Small.....	1-1	50	60	Striped bass:			
Haddock:				Large.....	10-15	110	120
Medium.....	3-5	60	70	Small.....	1-1 ^a	70	80
Small.....	1-2	50	60	Sucker, medium.....	1-1 ^a	80	90
Halibut, medium.....	50-90	70	80	Tilefish, medium.....	6-12	90	100
Hickory shad, medium.....	1-2	60	70	Whiting, medium.....	1-1	50	60
Hogfish.....	1-1 ^a	50	60				
Kingfish, medium.....	1-1	60	70				

^a From 5 to 7 to the pound.^b From 15 to 20 to the pound.

Some experiments have recently been made to apply a known principle to the domestic canning of fish so as to obviate the necessity for employing a pressure cooker. The reference is to boiling the cans or jars in a saturated salt solution; that is, at 228° F. for a time. For this process, only apparatus usually found in the home, such as a wash boiler, is employed. By this method, the bones are softened satisfactorily and the fish thoroughly cooked, and difficulties in closing fruit jars to withstand the pressure created are overcome. Nearly 100 containers of glass and tin have been processed and some success has been attained. It is planned to make additional tests before recommending the use of the method to the public.

DEVELOPMENT OF AQUATIC SOURCES OF LEATHER.

The Bureau has continued to cooperate effectively with tanners, fishermen, and others interested in the development of new sources of leather from the skins of aquatic animals. Among the advances to be recorded in this work during the past year the following may be mentioned: (1) The development of types of nets suitable for catching sharks and devices claimed to be satisfactory for quickly removing the hides from the fish; (2) progress in the development of methods suitable for tanning the hides of the smaller fishes on a commercial scale; (3) perfection of arrangements by tanners to engage in the industry; (4) establishment of connections with the fishing centers for supplies of raw materials; (5) preparations for the establishment at various points on our coasts of small plants for fishing for sharks, the flesh to be used for food, the liver oil to be extracted and marketed, the hides to be tanned into leather, and the refuse to be

used for fertilizer; and (6) experiments with leather made from fish skins to determine fitness for manufacture into shoes and other articles. The Bureau has also given assistance in expediting shipments of raw hides from producing centers to tanners.

A seine constructed for the Bureau, which has proved very successful for the capture of sharks up to 6 or 8 feet in length, is 600 yards long, 18 feet deep, with 4-inch bar mesh of 36 thread; top and bottom lines of one-half inch, 18-thread rope, fitted with seine corks 5 inches in diameter placed 2 feet apart on the cork line, and 4-ounce trap leads with the same interspace on lead line, the entire net being tarred. With this type of apparatus, from 50 to 200 sharks have been taken in a single day's fishing, and during the brief period in which two of these nets have been operated, approximately 2,000 sharks ranging in length from $3\frac{1}{4}$ to 15 feet have been taken. For the purpose of taking the larger sharks a heavier net of larger mesh is required. One now under construction which the Bureau believes will prove satisfactory is 300 yards long, 12 feet deep, with 10-inch bar mesh of 60-thread tarred cotton twine hung on three-eighths inch 12-thread rope, fitted with haul-seine corks 4 inches in diameter placed 3 feet apart on cork line and 2-ounce round leads placed 6 feet apart on lead line.

Through the cooperation of the Bureau of Standards the services of a technically trained tanner were obtained, and some tanning experiments were started at a large tannery with the company's cooperation. The tanner remained in this work only a short time before entering the military service and the results accruing should be credited largely to the company. The experiments showed that shark skins could be tanned into upper leather for shoes by known methods of tanning and also that the shagreen could be removed from the skins very satisfactorily. To do this, the hides, after tanning and neutralizing, are first coated with paraffin and oil, tacked and dried. They are then smooth plated and shaved on the grain side to remove the coarsest part of the denticles, and the grain is then gone over lightly on a rapidly revolving carborundum wheel. After this treatment the hides are ready for finishing. Some of the hides have been given a gun-metal finish suitable for shoes, others have been tanned for lining leather and as cordovan. The average tensile strength of two shark skins submitted to the Bureau was 3,905 and 4,742 pounds per square inch.

Owing to shortage of labor, transportation difficulties, and other drawbacks, progress in the development of this industry has been somewhat retarded. In fact, it has practically become necessary for the tanning companies to start fisheries of their own at various points along the coast to insure a supply of raw materials at the present time. With the increase in demand for shark meat and oil, the fishermen are showing increased interest in the fishery, and the outlook is regarded as promising.

NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries centering at Boston and Gloucester, Mass., and Portland, Me., have been in a prosperous condition during the past year. There was some decrease in the quantity of fishery products

landed, but a large increase in the value, as compared with the previous year. The decline in quantity occurred at Gloucester and Portland, while there was considerable increase over the previous year in the receipts at Boston. Statistics of these fisheries have been collected during the year by the local agents and published in monthly bulletins showing by species and fishing grounds the quantities and values of fishery products landed by American fishing vessels at these ports. Two annual bulletins also have been issued, one showing the catch by months, and the other by fishing grounds.

The fishing fleet which landed fishery products at these ports during the calendar year 1917 included 493 sail, steam, and gasoline screw vessels. These vessels landed at Boston 2,962 trips, aggregating 98,650,139 pounds of fish, valued at \$5,166,440; at Gloucester, 3,074 trips, aggregating 58,134,944 pounds, valued at \$2,451,484; at Portland, 3,248 trips, aggregating 18,645,503 pounds, valued at \$743,408. The total for the three ports amounted to 9,284 trips, aggregating 175,430,586 pounds of fresh and salted fish, having a value to the fishermen of \$8,361,332. Compared with the previous year there was an increase of 339 trips, and a decrease of 10,393,839 pounds, or 5.59 per cent, in the quantity, with an increase of \$1,977,426, or 30.97 per cent, in the value of the fish landed. The catch of haddock decreased 7,000,957 pounds, hake 5,257,653 pounds, pollock, 1,095,838 pounds, cusk, 2,518,994 pounds, halibut 1,692,701 pounds, herring 5,494,676 pounds, and miscellaneous products 2,232,214 pounds, but all of these species except cusk, halibut, herring, and the miscellaneous products increased in value. The catch of Newfoundland herring decreased 4,462,479 pounds, or 39.58 per cent, in quantity, and \$98,202, or 30.12 per cent in value. The cod catch increased 12,823,966 pounds, or 29.39 per cent, in quantity, and \$813,952, or 52.28 per cent, in value, and the mackerel catch 1,535,714 pounds, or 9.65 per cent, in quantity and \$404,831, or 38.58 per cent, in value. There was also an increase in the catch of swordfish of 201,206 pounds, or 11.35 per cent, in quantity, and \$53,890, or 22.61 per cent, in value. The catch of tilefish landed at Boston during the year amounted to 1,211,450 pounds, valued at \$44,743, an increase over the previous year of 338,308 pounds, or 38.74 per cent, in quantity and \$20,448, or 84.16 per cent, in value.

The following tables present in detail, by fishing grounds and by months, the products of the vessel fisheries of Boston and Gloucester, Mass., and Portland, Me., for the calendar year 1917. The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. The grades, or sizes, given for certain species are those recognized in the trade.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917, SHOWN BY FISHING GROUNDS.

Fishing grounds.	Num-ber of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 24 pounds).				Scrod (1 to 24 pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.													
East of 66° west longitude.													
La Have Bank.....	21	271,580	\$16,756		203,311	\$8,419		31,980	\$642				
Western Bank.....	172	2,538,097	150,585		2,322,057	104,063		164,664	4,027				
Quereau Bank.....	11	63,850	3,110		40,100	1,345							
Grand Bank.....	1												
St. Peters Bank.....	4	31,525	1,662		37,130	1,149		2,100	33				
Cape Shore.....	54	300,361	20,019		378,038	14,830		161,450	2,943				
St. Anna Bank.....	1	30,100	1,505		22,600	678		2,250	34				
West of 66° west longitude.													
Browns Bank.....	160	1,287,960	75,151		1,502,859	57,567		242,845	4,769				
Georges Bank.....	481	3,271,229	191,520		3,297,689	133,751		291,210	6,868				
Cashes Bank.....	11	32,440	1,662		20,205	789		5,685	108				
Fippenles Bank.....	6	37,470	2,547		16,455	766		6,830	160				
Middle Bank.....	162	104,197	8,053		96,154	6,347		33,419	857				
Jedreys Lodge.....	516	276,544	20,428		248,510	13,592		69,140	1,749				
Jewichs Bay.....	2	175	15		400	28		200	4				
South Channel.....	251	811,777	51,097		1,011,060	46,269		272,820	5,964				
Nantucket Shoals.....	47	141,620	10,556		552,699	23,448		48,415	1,119				
Off Chatham.....	606	1,968,538	119,555		2,015,108	87,160		507,869	10,071				
Off Race Point.....	26	1,000	50		790	40		175	8				
Bay of Fundy.....	1	11,900	397		3,500	108		500	8				
South.....	39												
Shore, general.....	350	185,883	10,477		136,343	5,563		42,274	947				
Total.....	2,962	11,366,216	686,115		11,905,068	507,939		1,872,806	40,008				

LANDED AT GLOUCESTER.

East of 60° west longitude.

[illegible]

LANDED AT PORTLAND.

East of 88° west longitude.

[illegible]

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917, SHOWN BY FISHING GROUNDS—Continued.

Fishing Grounds.	Haddock.				Hake.			
	Large (over 24 pounds).		Scrod (1 to 24 pounds).		Large (6 pounds and over).		Small (under 6 pounds).	
	Fresh.	Salted.	Fresh.	Salted.	Fresh.	Salted.	Fresh.	Salted.
LANDED AT BOSTON.								
<i>East of 68° west longitude.</i>								
Le Have Bank.....	Pounds. 285,206	Value. \$17,595	Pounds. 85,610	Value. \$2,994	Pounds. 90,030	Value. \$4,497	Pounds. 149,555	Value. \$4,468
Western Bank.....	8,025,694	423,232	4,440,717	150,009	14,994		80,366	3,392
Quevren Bank.....	32,330	988	950	23			12,000	420
St. Peters Bank.....	87,245	4,999	9,155	147	5,400	270	4,700	204
Cape Shore.....	1,630,595	85,437	265,947	6,023	70,265	3,659	84,780	3,076
St. Ann's Bank.....	13,300	665	1,000	15			70	4
<i>West of 68° west longitude.</i>								
Brown's Bank.....	3,689,990	176,215	603,890	13,039	47,110	2,324	116,230	4,377
Georges Bank.....	4,260,092	190,928	1,718,895	61,964	38,350	1,601	50,395	1,939
Cashes Bank.....	13,335	720	610	20	19,625	1,348	87,068	3,763
Pippenes Bank.....	23,240	642	4,735	194	3,550	205	7,400	335
Middle Bank.....	494,402	86,984	51,851	2,188	104,780	7,555	477,285	21,462
Jaffrey's Ledge.....	1,846,918	123,250	328,796	15,367	181,437	13,643	1,007,251	51,557
South Channel.....	7,108,997	352,413	2,834,885	96,300	184,819	9,154	1,426,064	16,767
Nantucket Shoals.....	101,775	6,683	8,625	351	2,445	153	477,020	311
Off Chatham.....	6,355,050	346,792	1,048,924	37,810	195,890	10,173	477,467	20,632
Off Race Point.....	1,875	94			89,000	2,670	300	9
Bay of Fundy.....	5,135	154			266,844	14,789	675,853	25,025
Shore, general.....	166,048	9,867	10,055	407				
Total.....	34,042,297	1,785,206	11,474,315	386,211	1,314,460	72,879	3,665,866	157,661

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917, SHOWN BY FISHING GROUNDS—Continued.

Fishing grounds.	Follock.		Cusk.		Halibut.	
	Fresh.		Fresh.		Fresh.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.						
East of 66° west longitude.						
La Have Bank.....	27,016	8862	116,605	\$4,054	9,682	\$1,788
Western Bank.....	453,212	17,737	42,825	1,370	86,409	11,606
Green Bank.....	1,126	33	22,245	730	111,291	15,190
Grand Bank.....					46,000	3,680
St. Peters Bank.....	300	11			6,010	1,163
Cape Shore.....	26,540	937	152,599	5,302	12,438	2,357
West of 66° west longitude.						
Brown Bank.....	220,352	9,185	707,848	23,120	98,028	17,309
George Bank.....	517,864	21,699	118,443	4,075	86,949	10,378
Charles Bank.....	21,306	668	81,943	2,857	10,715	110
Whitings Bank.....	18,740	859	51,245	1,870	1,771	303
Middle Bank.....	184,741	8,372	115,383	3,455	1,018	303
Fedwards Lodge.....	918,088	43,016	337,283	13,409	10,080	1,880
Jewett Bay.....	26,389	1,262	43,940	1,553	33,078	5,473
South Channel.....	30,863	1,370	8,315	338	4,516	875
Ordnance Shoals.....	90,189	41,596	96,940	3,161	37,826	6,692
Off Chatham.....	1,590	80				
Off New Point.....	1,100	17	9,550	328	600	120
Bay of Fundy.....	361,077	15,474	144,668	4,764	5,197	740
Shore, general.....						
Total.....	4,008,279	178,544	2,082,048	71,416	490,478	80,041
LANDED AT GLOUCESTER.						
East of 66° west longitude.						
La Have Bank.....	2,640	46	146,575	3,303	92,655	11,375
Western Bank.....	12,835	237	98,790	2,266	59,833	6,128
Green Bank.....	121,788	2,204	28,027	2,677	184,842	16,134
Green Bank.....			1,200	29	45,000	6,360
Grand Bank.....	1,475	28	22,492	522	185,647	14,112
Basallen Bank.....					12,475	1,115
Off Newfoundland.....	3,260	57			8,730	1,020
Cape North.....	8,822	161	42,870	922	5,550	301
Cape Shore.....	4,305	78	30,725	716	138,404	18,091
The Gully.....						

West of 66° west longitude.

Brown Bank.....	9,045	166				37,730	664				106,134	10,441		
Georges Bank.....	11,543	206				80,076	1,867				2,830	213		
Nantucket Shoals.....	1,310	23			12	29,350	662				13,670	2,065		
Beal Island.....	1,020	19				59,314	1,113							
Shore, general.....	8,985,628	360,985												
Total.....	9,137,659	364,119	39,870	1,204		577,148	12,821	20,405	608		907,770	96,373	42,364	3,604
LANDED AT PORTLAND.														
<i>East of 66° west longitude.</i>														
La Have Bank.....	325	13				1,125	45				23,766	3,995		
Western Bank.....	60,625	1,108				21,130	505				66,319	8,667		
Quebec Bank.....	395	12									19,667	1,917		
Grand Bank.....	940	13									131,541	13,018		
St. Peters Bank.....											35,818	5,903		
Bocallien Bank.....											24,170	2,970		
<i>West of 66° west longitude.</i>														
Brown Bank.....	1,965	40				540	19				1,458	262		
Georges Bank.....	1,985	59				3,980	100				2,435	65		
Cashes Bank.....	17,759	467				208,607	5,946				147	359		
Platts Bank.....	3,739	145				11,850	478				3,033	21		
Jaffreys Ledge.....	37,367	1,525				90,685	3,927	1,055	21		3,414	343		
South Channel.....	3,265	41									16	222		
Bay of Funday.....	250	5				6,950	177				14,206	1,440		
Shore, general.....	1,192,957	41,961	412	12		551,335	23,001	2,445	50					
Total.....	1,321,572	45,389	412	12		896,272	34,198	3,500	71		325,452	39,214		
Grand total.....	14,467,510	578,052	40,282	1,216		3,526,398	118,435	23,905	679		1,723,700	215,628	42,364	3,604

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917, SHOWN BY FISHING GROUNDS—Continued.

Fishing grounds.	Mackerel.									
	Large (over 2½ pounds).				Medium (1½ to 2½ pounds).				Small (under 1½ pounds).	
	Fresh.		Salted.		Fresh.		Salted.		Fresh.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.										
East of 68° west longitude.										
Western Bank.....	15,000	\$1,650			82,345	\$9,491				
Cape Shore.....	1,730,227	91,543	173,700	\$10,497	231,663	8,966				
West of 68° west longitude.										
Georges Bank.....	394,160	33,550	43,400	4,288	46,326	2,134				
Middle Bank.....	211,696	21,993	1,400	210	224,490	28,080				
South Channel.....	8,200	1,057								
Nantucket Shoals.....	105,205	10,300			43,265	2,112				
Off Chatham.....	1,588,407	121,141			1,076,918	76,343				
Off Race Point.....	232,499	26,212			376,827	40,396				
South.....	8,599	1,022								
Shore, general.....	1,535,513	127,837	1,400	210	501,862	43,617	3,600	\$270	282,050	24,707
Total.....	5,839,801	435,325	219,900	15,205	2,574,546	211,151	3,600	270	933,099	73,246
LANDED AT GLOUCESTER.										
East of 68° west longitude.										
Cape North.....	65,715	4,303	493,300	36,290	76,517	4,709	714,900	51,806		

[illegible]

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917, SHOWN BY FISHING GROUNDS.—Continued.

Fishing grounds.	Miscellaneous.				Total.				Grand total.
	Fresh.		Salted.		Fresh.		Salted.		
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	
LANDED AT BOSTON.									
East of 66° west longitude.									
La Have Bank.....	19,468	\$317			1,301,019	\$82,583			\$82,583
Western Bank.....	106,769	5,481			18,343,149	\$83,561			\$83,561
Queen Bank.....					283,911	21,839			21,839
Grand Bank.....					46,000	3,680			3,680
St. Peter Bank.....	2,000	40			184,485	9,178			9,178
Cape Shore.....	25,321	2,079			5,057,294	247,921			5,230,924
St. Ann's Bank.....					69,320	2,901			69,320
West of 66° west longitude.									
Browns Bank.....	88,806	4,756			8,583,860	\$92,712			\$92,712
Georges Bank.....	2,102,953	294,990			16,226,532	\$61,191			16,296,932
Cashes Bank.....	9,925	284			177,377	8,083			177,377
Fippinlee Bank.....	4,426	99			2,205,603	149,830			2,206,083
Middle Bank.....	101,617	3,361			5,708,018	316,461			5,708,018
Jeffreys Ledge.....	483,961	12,660			8,590	505			8,590
Ipswich Bay.....	1,365	66			13,746,374	\$67,363			13,746,374
South Channel.....	727,646	26,837			60,854	48,800			157,557
Nantucket Shoals.....	52,984	1,487			17,629,319	\$94,616			17,770,519
Off Chatham.....	686,679	17,110			67,181	67,181			133,865
Off Race Point.....	2,280	176			3,835	3,835			7,670
Bay of Fundy.....	1,700	136			1,221,239	46,877			1,221,239
South.....	1,211,450	44,743			5,241,690	\$65,973			5,320,135
Shore, general.....	9,285,043	21,763							
Total.....	6,615,341	425,826			98,154,629	\$5,122,568			98,650,139
LANDED AT GLOUCESTER.									
East of 66° west longitude.									
La Have Bank.....					495,485	21,477			505,375
Western Bank.....					1,705,905	51,504			2,042,908
Queen Bank.....					16,276,534	442,458			22,192,813
Green Bank.....					64,064	6,871			5,917,264
Grand Bank.....					664,079	28,774			4,523
Beaken Bank.....					77,735	3,066			1,040,334
Off Newfoundland.....					642,111	17,669			19,579
Cape North.....					169,326	8,843			37,556
Cape Shore.....					517,143	21,517			1,115,291
The Gully.....					587,841	26,643			6,938,179
Total.....									24,545
									6,915,145
									1,740,133
									85,367
									3,074
									6,215,145
									253,214
									7,623
									110,116
									31,158
									21,984
									67,519
									727,543
									7,338
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596
									4,596

West of 66° west longitude.

Brown Bank.....	889,800	25,573	889,800	8,901	889,800	22,573
Georges Bank.....	1,047,770	47,004	1,047,770	8,901	1,136,356	55,905
Middle Bank.....				8,808	54,200	8,808
South Channel.....	70,940	2,268	70,940		70,940	2,268
Nantuxet Shoals.....	1,680,286	76,543	1,680,286	384,066	4,756,302	461,029
Off Chatham.....	205,338	8,709	205,338	13,679	345,603	22,388
Off Chatham.....	101,068	4,112	101,068		101,068	4,112
Seal Island.....	15,017,510	874,879	15,017,510	39,532	15,352,716	614,481
Shore, general.....						
Total.....	3,404,964	80,268	40,002,008	1,065,134	58,134,944	2,461,484

LANDED AT PORTLAND.

East of 66° west longitude.

La Have Bank.....	530	4,420	31,708		31,708	4,420
Western Bank.....	26,877	187,484	4,380,791	1,448	4,407,791	158,932
Grand Bank.....	9,708	4,910	124,837	5,370	139,237	5,139
St. Peter's Bank.....	24	13,198	143,115	42,115	184,278	15,479
Beaulieu Bank.....		5,908	35,818	2,283	35,818	5,908
Total.....		2,970	24,170		24,170	2,970

West of 66° west longitude.

Brown Bank.....	13,892	2,944	31,605		31,605	2,944
Georges Bank.....	33,808	8,283	148,850		148,850	8,283
Charles Bank.....	283,767	16,724	700,580		700,580	16,724
Platts Bank.....	4,310	2,501	49,804		49,804	2,501
Jefferys Lodge.....	186,788	45,456	904,108	1,055	905,160	45,457
South Channel.....		17,704	504,979		504,979	17,704
Bay of Fundy.....	400	30,898	30,898		30,898	
Shore, general.....	3,345,564	457,817	11,465,092	149	11,465,678	457,966
Total.....	3,907,240	73,267	18,566,377	79,126	18,645,503	743,466
Grand total.....	13,997,545	546,361	156,788,104	1,133,136	175,639,546	8,361,352

Filefish.

Herring. Other items under "Miscellaneous" include bluebacks, 83,438 pounds, value \$706; bonito, 100 pounds, value \$2; butterfish, 21,907 pounds, value \$1,900; catfish or wolffish, 207,138 pounds, value \$6,131; eels, 4,720 pounds, value \$468; flounders, 1,279,721 pounds, value \$4,498; grayfish, 6,100 pounds, value \$41; herring, 6,323,808 pounds, value \$70,813; horse mackerel, 3,560 pounds, value \$90; redfish, 131,527 pounds, value \$3,877; salmon, 448 pounds, value \$84; shad, 153,388 pounds, value \$3,146; sharks, 83,673 pounds, value \$1,789; skates, 700,386 pounds, value \$15,412; smelt, 50,680 pounds, value \$4,914; sturgeon, 2,235 pounds, value \$190; swordfish, 1,733,518 pounds, value \$322,168; tomcod, 40 pounds, value \$2; halibut, 1,300 pounds, value \$27; porpoise, 400 pounds, value \$2; lobster, 362 pounds, value \$224; squid, 20,935 pounds, value \$391; livers, 959,426 pounds, value \$19,780; sounds, 33,333 pounds, value \$3,336; spawn, 145,691 pounds, value \$9,334; and tongues, 1,088 pounds, value \$41.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE YEAR 1917, SHOWN BY MONTHS.

Month.	Num-ber of trips.	Cod.									
		Large (10 pounds and over).					Market (under 10 and over 2½ pounds).				
		Fresh.		Salted.		Fresh.		Salted.		Fresh.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.											
January.....	191	370,473	\$23,651	414,508	\$15,504	815,504	\$2,833	145,889	3,124	1,750	\$44
February.....	197	451,022	35,236	537,987	25,198	142,178	3,124	142,178	3,124	1,750	\$44
March.....	214	628,434	41,311	542,462	22,508	75,157	1,644	75,157	1,644	1,750	\$44
April.....	177	679,208	37,631	662,728	27,559	108,135	2,072	108,135	2,072	1,750	\$44
May.....	198	1,527,822	63,929	1,059,281	36,230	108,135	2,072	108,135	2,072	1,750	\$44
June.....	253	1,178,574	55,091	1,208,121	43,142	187,417	3,445	187,417	3,445	1,750	\$44
July.....	327	1,076,752	61,566	1,362,241	58,161	174,780	3,409	174,780	3,409	1,750	\$44
August.....	394	800,575	55,371	1,184,147	64,518	214,626	4,474	214,626	4,474	1,750	\$44
September.....	292	1,063,921	70,519	1,308,596	58,347	204,037	4,492	204,037	4,492	1,750	\$44
October.....	326	1,086,222	77,624	1,308,912	58,775	172,089	4,003	172,089	4,003	1,750	\$44
November.....	223	1,403,971	86,861	1,301,314	56,100	183,866	3,119	183,866	3,119	1,750	\$44
December.....	171	1,099,192	76,408	1,061,683	63,215	213,828	5,052	213,828	5,052	1,750	\$44
Total.....	2,962	11,366,216	685,115	11,005,068	597,939	1,872,806	40,098	1,872,806	40,098	1,750	\$44
LANDED AT GLOUCESTER.											
January.....	215	68,065	2,731	41,000	1,077	8,170	\$277	94,920	762	1,750	\$44
February.....	144	131,178	11,565	2,665	80	2,804	112	2,804	112	1,750	\$44
March.....	245	488,169	34,469	4,062	107	5,300	208	5,300	208	1,750	\$44
April.....	328	813,464	39,235	184,245	5,071	1,079	49	1,079	49	1,750	\$44
May.....	518	1,347,060	53,237	788,226	21,673	1,079	49	1,079	49	1,750	\$44
June.....	172	1,384,227	51,296	1,897,136	56,233	771,253	35,062	41,306	678	62,007	2,081
July.....	91	1,654,830	49,669	2,303,712	62,703	512,360	22,765	171,725	756	53,555	1,169
August.....	199	2,240,864	61,926	3,306,487	81,703	777,340	33,261	120,700	1,799	72,573	2,467
September.....	111	971,668	27,111	1,367,100	31,692	291,155	12,808	30,100	206	27,397	861
October.....	106	404,334	12,186	18,873	8,502	568,668	27,827	16,870	206	26,035	975
November.....	486	183,032	8,573	332,133	2,178	412,320	26,064	1,350	20	52,980	2,540
December.....	338	87,260	5,473	10,728	2,265	2,000	90	1,350	20	1,020	31
Total.....	3,074	9,963,851	357,430	2,864,661	146,756	3,327,379	157,573	430,261	5,038	279,406	10,226

LANDED AT PORTLAND.

[illegible]

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE YEAR 1917, SHOWN BY MONTHS—Continued.

Month.	Haddock.				Scrod (1 to 24 pounds).				Hake.			
	Large (over 24 pounds).		Salted.		Fresh.		Salted.		Large (6 pounds and over).		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.												
January.....	3,220,676	\$173,893	.....	.....	1,461,842	\$45,513	.....	.....	56,416	\$4,113	.....	.....
February.....	4,130,626	226,696	.....	.....	2,083,642	67,309	.....	.....	38,763	3,009	.....	.....
March.....	4,832,632	227,092	.....	.....	1,889,094	66,863	.....	.....	26,090	2,119	.....	.....
April.....	2,943,228	141,285	.....	.....	964,020	36,966	.....	.....	23,783	1,473	.....	.....
May.....	2,278,318	106,279	.....	.....	672,350	21,718	.....	.....	60,690	2,747	.....	.....
June.....	2,069,660	92,896	.....	.....	735,880	27,614	.....	.....	68,755	2,963	.....	.....
July.....	1,748,340	88,562	.....	.....	558,000	18,673	.....	.....	167,319	8,329	.....	.....
August.....	2,591,370	111,421	.....	.....	498,419	15,299	.....	.....	319,915	12,813	.....	.....
September.....	3,023,720	149,412	.....	.....	710,045	24,508	.....	.....	281,410	13,163	.....	.....
October.....	2,951,614	169,448	.....	.....	688,965	27,236	.....	.....	176,432	10,602	.....	.....
November.....	2,600,035	155,768	.....	.....	742,866	26,508	.....	.....	121,943	8,972	.....	.....
December.....	1,962,279	147,499	.....	.....	533,962	24,014	.....	.....	24,064	2,556	.....	.....
Total.....	34,042,267	1,785,206	.....	.....	11,474,315	396,211	.....	.....	1,314,499	72,879	.....	.....
LANDED AT GLOUCESTER.												
January.....	81,335	4,067	140	\$5	.....	.....	.....	.....	18,846	1,468	20	\$1
February.....	76,291	5,602	140	3	.....	.....	.....	.....	1,845	111	475	14
March.....	43,911	3,071	305	30	.....	.....	550	\$14	6,090	109	260	8
April.....	364,363	18,169	.....	.....	.....	.....	.....	.....	1,810	37	.....	.....
May.....	622,834	33,621	.....	.....	.....	.....	.....	.....	9,920	182	.....	.....
June.....	320,944	6,621	24,365	787	3,000	60	.....	.....	36,127	726	55,053	1,002
July.....	468,745	9,593	45,433	1,363	46,745	497	.....	.....	73,206	1,641	6,300	160
August.....	286,634	5,606	36,273	1,068	8,400	42	.....	.....	253,225	6,103	2,682	81
September.....	184,860	3,667	36,735	1,076	.....	.....	.....	.....	134,576	3,269	4,300	125
October.....	24,680	508	5,945	192	.....	.....	50	2	128,070	3,140	3,920	106
November.....	76,620	3,255	10,155	365	.....	.....	.....	.....	44,871	2,339	.....	.....
December.....	6,176	409	.....	.....	3,150	95	.....	.....	27,801	2,400	140	4
Total.....	2,665,187	92,977	199,468	4,899	64,715	699	600	16	733,866	21,555	72,202	2,241
											1,570	56

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE YEAR 1917, SHOWN BY MONTHS—Continued.

Month.	Pollock.				Cusk.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.												
January.....	85,410	\$3,202	.....	.....	187,078	\$5,706	.....	.....	13,647	\$3,704	.....	.....
February.....	117,940	6,343	.....	.....	219,563	8,368	.....	.....	36,962	9,015	.....	.....
March.....	118,635	7,024	.....	.....	191,466	8,156	.....	.....	32,423	8,799	.....	.....
April.....	168,659	7,379	.....	.....	135,126	4,223	.....	.....	32,423	8,680	.....	.....
May.....	246,002	9,016	.....	.....	202,260	8,890	.....	.....	70,001	9,577	.....	.....
June.....	300,445	10,840	.....	.....	73,196	2,064	.....	.....	136,295	14,080	.....	.....
July.....	476,466	23,421	.....	.....	133,264	4,418	.....	.....	17,457	3,046	.....	.....
August.....	392,528	20,021	.....	.....	133,863	4,037	.....	.....	36,845	8,762	.....	.....
September.....	560,872	27,065	.....	.....	177,860	6,287	.....	.....	26,824	6,321	.....	.....
October.....	846,905	36,276	.....	.....	214,543	7,542	.....	.....	62,881	11,308	.....	.....
November.....	426,283	16,070	.....	.....	215,466	7,599	.....	.....	16,617	4,351	.....	.....
December.....	251,160	11,595	.....	.....	165,267	6,517	.....	.....	7,964	2,518	.....	.....
Total.....	4,005,279	178,544	.....	.....	2,053,048	71,416	.....	.....	460,478	80,041	.....	.....
LANDED AT GLOUCESTER.												
January.....	2,154,159	67,147	240	\$7	110	2	478	814	20,280	2,047	.....	.....
February.....	1,173,901	11,025	600	12	400	12	50	2	35,885	6,018	.....	.....
March.....	85,501	6,118	400	10	400	8	.....	.....	96,410	9,514	.....	.....
April.....	183,071	8,205	.....	.....	20,890	344	.....	.....	8,656	9,904	.....	.....
May.....	303,543	12,662	.....	.....	81,915	1,558	.....	.....	79,838	10,070	.....	.....
June.....	439,151	6,995	11,510	345	44,221	1,004	5,815	188	222,489	18,815	21,106	\$2,064
July.....	65,180	1,207	7,720	240	166,976	3,961	2,010	66	131,495	11,339	14,051	509
August.....	36,335	663	11,153	323	156,287	3,622	.....	.....	161,076	17,612	6,245	33
September.....	14,892	238	2,797	84	76,085	1,721	.....	.....	136,488	18,086	.....	.....
October.....	835,210	32,854	4,085	125	14,980	365	12,005	336	12,443	1,367	.....	.....
November.....	2,902,430	114,563	1,280	44	9,085	224	50	2	2,845	.....	.....	.....
December.....	1,865,206	92,712	1,165	5	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	9,137,659	354,119	29,870	1,204	577,148	12,831	20,405	608	907,770	96,373	42,364	3,804

LANDED AT PORTLAND.

January.....	126,897	5,179	.....	68,476	3,008	1,700	34	3,081	501	.....
February.....	107,968	7,544	.....	40,285	2,154	1,455	10	135	20	.....
March.....	107,660	5,917	12	80,579	2,762	1,000	22	20,454	1,068	.....
April.....	212,018	6,991	412	209,789	7,440	66	2	2,723	518	.....
May.....	115,551	2,573	.....	139,188	8,397	.....	.....	4,572	524	.....
June.....	68,790	1,520	.....	28,545	804	250	3	67,792	6,204	.....
July.....	31,262	1,005	.....	23,935	955	.....	.....	45,082	5,412	.....
August.....	54,268	1,002	.....	11,274	496	.....	.....	96,008	11,522	.....
September.....	147,109	3,804	.....	87,011	2,438	.....	.....	42,540	1,904	.....
October.....	111,854	3,542	.....	89,243	2,575	.....	.....	36,440	5,094	.....
November.....	118,138	4,012	.....	102,483	4,649	.....	.....	26,508	5,257	.....
December.....	68,038	2,000	.....	50,145	2,511	.....	.....	2,890	162	.....
Total.....	1,321,572	45,889	412	996,202	34,198	3,500	71	325,452	39,214	.....
Grand total.....	14,467,510	578,082	40,292	3,535,398	118,485	23,905	679	1,728,700	215,038	42,364
Grounds E. of 66° W. long.....	728,612	25,817	1,192	737,208	20,471	20,405	608	1,264,377	157,079	42,364
Grounds W. of 66° W. long.....	13,741,898	554,265	1,013	2,798,190	97,964	3,500	71	1,469,323	68,549	.....
Landed at Boston in 1916.....	3,792,160	108,797	.....	3,657,429	77,702	.....	.....	1,141,065	144,128	.....
Landed at Gloucester in 1916.....	10,117,138	238,080	78,168	1,553,926	22,263	34,000	869	1,691,282	175,255	.....
Landed at Portland in 1916.....	1,568,126	36,771	23,975	808,172	18,480	17,770	166	833,314	57,662	.....

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE YEAR 1917, SHOWN BY MONTHS—Continued.

Month.	Mackerel.									
	Large (over 2½ pounds).				Medium (1½ to 2½ pounds).				Small (under 1½ pounds).	
	Fresh.		Salted.		Fresh.		Salted.		Fresh.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.										
May.....	8,800	\$1,022	173,700	\$10,497	880	\$62	3,600	\$270		
June.....	1,897,719	103,122	64,532	4,288	221,663	8,966			7,500	\$675
July.....	927,975	64,532	43,400	2,888	93,206	5,276			372,713	22,262
August.....	1,418,708	105,236			831,143	51,950			382,966	24,200
September.....	656,507	64,418	2,800	420	636,609	55,716			166,920	16,219
October.....	932,738	96,469			788,692	88,675				
November.....	2,253	496			2,354	506				
December.....										
Total.....	5,839,801	435,325	219,930	15,295	2,574,546	211,151	3,600	270	953,099	73,246
LANDED AT GLOUCESTER.										
June.....	78,025	4,488	495,300	39,299	77,547	4,802	724,440	52,551		
July.....	7,400	565	39,000	2,820	50,180	1,703	247,025	23,674		
August.....					296,821	12,624	433,953	50,045		
September.....	108,290	6,497	177,000	26,532	115,798	6,992	314,296	40,371	1,099,430	52,363
October.....	83,710	2,860	585,000	90,142	7,240	579	38,000	5,468	232,800	12,189
November.....			4,300	744			18,200	2,361		
Total.....	227,425	13,910	1,301,700	156,646	517,596	25,900	1,778,954	174,470	1,831,030	64,553
LANDED AT PORTLAND.										
June.....	234	28			57	7				
July.....	3,891	514			2,634	268			447	50
August.....	10,090	1,141			50,071	3,728			21,548	1,681
September.....	486,965	32,454			49,173	3,439			32,410	883
Total.....	490,840	34,167			101,865	7,442			54,706	1,964
Grand total.....	6,518,066	482,402	1,521,600	171,951	3,194,017	244,363	1,772,554	174,740	2,310,734	139,762
Grounds F. of 66° W. long.										
Grounds F. of 66° W. long.	1,819,942	97,916	699,000	46,706	380,526	28,166	714,800	51,806		
Landed at Boston in 1916.....	4,694,124	385,896	892,000	126,055	2,813,492	221,227	1,067,764	122,974		
Landed at Gloucester in 1916.....	5,191,892	327,474	20,000	1,260	2,341,095	146,599	47,800	4,161	2,319,731	139,762
Landed at Gloucester in 1916.....	844,858	14,518	1,825,066	146,132	840,163	59,257	2,203,131	263,178	891,065	42,370
Landed at Portland in 1916.....	213,873	11,792			217,124	10,063	1,066	108	322,860	15,767
Total.....	12,019,667	733,556	1,926,066	168,153	7,754,730	475,815	3,986,761	389,126	5,454,385	289,911

Month	Miscellaneous				Total.				Grand total.
	Fresh		Salted		Fresh.		Salted.		
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	
LANDED AT BOSTON.									
January.....	143,798	\$7,288			Pounds.	Value.	Pounds.	Value.	
February.....	120,729	6,708			6,281,716	\$256,569	6,281,716	\$256,569	
March.....	236,683	9,709			7,983,886	386,369	7,983,886	386,369	
April.....	598,667	14,293			8,457,867	386,106	8,457,867	386,106	
May.....	177,669	20,386			9,317,795	391,510	9,317,795	391,510	
June.....	176,353	32,634			6,453,297	498,249	6,453,297	498,249	
July.....	1,161,808	143,143			6,483,467	408,586	6,483,467	408,586	
August.....	1,260,983	128,197			8,212,204	394,725	8,212,204	394,725	
September.....	307,964	38,451			10,451,829	604,825	10,451,829	604,825	
October.....	307,862	19,019			9,794,158	567,084	9,794,158	567,084	
November.....	216,651	7,071			10,283,110	639,550	10,283,110	639,550	
December.....	148,469	6,567			7,819,104	403,430	7,819,104	403,430	
Total.....	6,615,241	425,826			5,734,842	349,948	5,734,842	349,948	
					98,154,629	5,122,568	498,510	43,872	
LANDED AT GLOUCESTER.									
January.....									
February.....									
March.....	487,946	15,494	2,648,894	\$83,631	2,478,796	79,251	2,868,279	84,409	
April.....			2,463,316	75,923	911,771	49,953	2,502,330	76,307	
May.....	57,600	1,226			724,463	53,421	16,875	772	
June.....	1,526,610	19,752			1,643,449	73,284			
July.....	1,265,332	9,974			152,254				
August.....	17,000	170			4,746,891	161,936	2,907,611	170,894	
September.....					6,074,160	142,936	3,547,863	85,368	
October.....					5,029,547	244,195	3,202,713	256,351	
November.....	30,476	3,662			7,962,019	1,691,580	170,831	4,962,852	
December.....					3,271,272	110,401	3,431,587	216,252	
Total.....	3,404,964	50,268	979,600	52,704	1,809,587	62,028	1,691,580	144,179	
					3,431,897	135,410	425,840	176,250	
					1,968,217	101,309	964,115	52,953	
Total.....					40,062,068	1,366,350	18,072,846	1,086,124	
					212,317		58,124,944	2,451,494	

* Includes herring from Newfoundland, 487,946 pounds frozen value \$15,484, and 6,321,810 pounds salted, value \$212,317.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER MASS., AND PORTLAND, ME., BY AMERICAN FISHING VESSELS DURING THE YEAR 1917, SHOWN BY MONTHS—Continued.

Month.	Miscellaneous.				Total.				Grand total.	
	Fresh.		Salted.		Fresh.		Salted.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.		
LANDED AT PORTLAND.										
January.....	63,066	\$2,206			851,533	\$16,490	1,700	\$34	853,263	\$16,514
February.....	65,464	2,201			668,871	87,011	1,455	10	690,326	87,021
March.....	106,324	2,599			1,126,615	56,065	5,782	263	1,135,397	56,328
April.....	34,244	831			1,681,487	67,581	65	2	1,681,552	67,583
May.....	415,112	4,708			1,384,345	38,019			1,384,345	38,019
June.....	2,526,282	28,082			3,219,984	52,353	42,305	2,286	3,263,379	54,639
July.....	136,863	3,188			1,708,450	87,448	27,000	1,448	1,735,450	88,903
August.....	186,365	12,224			2,146,094	98,963	1,729	87	2,147,823	99,040
September.....	113,460	7,529			2,128,402	107,437			2,128,402	107,437
October.....	136,132	2,065			1,963,875	88,094			1,963,875	88,094
November.....	126,874	4,568			1,021,219	54,637			1,021,219	54,637
December.....	66,084	2,129			663,452	44,203			663,452	44,203
Total.....	3,907,240	72,267			18,566,377	786,278	79,126	4,130	18,645,503	743,408
Grand total.....	13,927,545	548,361	6,321,810	\$312,317	156,783,104	7,228,196	18,647,483	1,133,136	175,430,586	8,361,332
Grounds E. of 66° W. long.....										
Grounds W. of 66° W. long.....	676,717	28,303	6,321,810	212,317	51,123,977	2,049,783	14,605,809	644,565	65,720,786	2,604,348
Landed at Boston in 1916.....	13,281,828	529,058			105,660,127	5,178,413	41,041,673	488,571	106,700,800	5,696,964
Landed at Gloucester in 1916.....	6,712,473	375,290			96,284,686	3,665,994	76,400	6,371	96,331,088	3,702,865
Landed at Gloucester in 1916.....	7,318,563	160,178			46,518,277	1,812,013	20,165,271	947,881	46,680,548	2,169,984
Landed at Portland in 1916.....	6,182,411	71,421	7,228,224	183,344 2	20,581,304	513,671	261,445	7,976	20,812,889	743,408

The large quantity of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels is taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1917, 62.47 per cent of the quantity and 67.72 per cent of the value of the catch landed by the American fishing fleet at these ports were taken from these grounds; 4.91 per cent of the quantity and 3.94 per cent of the value, consisting chiefly of herring, were taken from fishing banks off the coast of Newfoundland; and 32.61 per cent of the quantity and 28.32 per cent of the value were from grounds off the Canadian Provinces. The receipts of Newfoundland herring constituted 3.88 per cent of the quantity and 2.72 per cent of the value of the fishery products landed at these ports during the year. The herring were taken on the treaty coasts of Newfoundland, but cod and other species from that region were obtained chiefly from fishing banks on the high seas. All fish caught by American fishing vessels off the Canadian Provinces were from offshore fishing grounds. The catch from each of these regions is given in detail in the following table:

QUANTITY AND VALUE OF FISH LANDED BY AMERICAN FISHING VESSELS AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., IN 1917 FROM GROUNDS OFF THE COAST OF THE UNITED STATES, NEWFOUNDLAND, AND CANADIAN PROVINCES.

Species.	United States.		Newfoundland.		Canadian Provinces.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Cod:								
Fresh.....	26,064,491	\$1,210,066	584,278	\$18,247	24,224,088	\$821,040	49,872,857	\$2,049,353
Salted.....	8,846	426	477,160	24,390	6,087,686	206,666	6,573,691	331,483
Haddock:								
Fresh.....	33,810,941	1,675,131	97,275	4,665	19,486,646	831,996	53,394,742	2,511,787
Salted.....	140	3	4,885	165	164,948	4,743	160,033	4,964
Hake:								
Fresh.....	6,673,922	302,371	106,296	2,882	1,000,347	33,770	7,339,556	339,061
Salted.....	1,720	87	10,645	318	62,717	1,966	75,091	2,361
Pollock:								
Fresh.....	13,740,873	554,496	5,965	109	720,667	23,447	14,467,510	578,018
Salted.....	1,012	24	1,522	45	37,748	1,147	40,282	1,216
Cusk:								
Fresh.....	2,738,876	96,851	28,692	551	762,830	21,063	3,525,398	118,435
Salted.....	3,500	71	5,815	188	14,560	420	23,906	679
Hallibut:								
Fresh.....	445,733	66,454	474,391	49,331	808,556	99,843	1,728,700	215,628
Salted.....			12,571	1,366	29,793	2,238	42,364	3,604
Mackerel:								
Fresh.....	9,831,380	746,875			2,200,467	120,682	12,031,817	867,557
Salted.....	4,026,446	457,960			1,353,800	98,602	5,410,246	586,563
Herring:								
Fresh.....	6,319,808	70,736	487,946	15,484	9,000	77	6,816,754	86,297
Salted.....			6,321,810	212,817			6,321,810	212,317
Swordfish:								
Fresh.....	1,944,684	238,246			28,834	3,923	1,973,518	292,169
Tilapia:								
Fresh.....	1,211,450	44,743					1,211,450	44,743
Miscellaneous:								
Fresh.....	3,775,886	118,833	2,094	41	147,913	6,778	3,925,823	125,153
Total.....	109,999,712	5,662,872	8,615,265	330,100	57,215,609	2,368,360	175,430,586	8,361,333

Cod.—In 1917 the fishing fleet landing fish at Boston, Gloucester, and Portland was not quite so large as in the previous year. There were 6 vessels employed in the salt bank fishery and 88 in the market fishery, landing their fares of cod and other ground fish at these ports. Large quantities of cod were also landed by vessels fishing on the shore grounds. The total quantity of cod landed during the year was 56,446,528 pounds, valued at \$2,370,834, of which 49,872,837

pounds, valued at \$2,049,352, were fresh, and 6,573,691 pounds, valued at \$321,482, were salted.

Haddock.—The catch of haddock during the year was smaller than that of cod in quantity, but greater in value. There was a decrease in the catch as compared with the previous year of 7,000,957 pounds, or 11.56 per cent, in quantity, but an increase of \$755,027, or 42.85 per cent, in the value. The total quantity landed during the year was 53,554,835 pounds, valued at \$2,516,702, all of which were fresh except 160,093 pounds, salted, valued at \$4,915.

Hake.—The yield of hake for the year was 7,914,646 pounds, valued at \$341,385, all landed fresh except 75,091 pounds, salted, valued at \$2,361. The catch declined 5,257,653 pounds, or 39.91 per cent, in quantity, but showed an increase of a little more than 1 per cent in value.

Pollock.—The pollock catch was nearly twice as large as that of hake, the quantity landed amounting to 14,507,792 pounds, valued at \$579,268. This product was all fresh, with the exception of 40,282 pounds, salted, valued at \$1,216. The catch was about 7 per cent less than that of the previous year in quantity, but increased 51 per cent in value.

Cusk.—The catch of cusk was 3,549,303 pounds, valued at \$119,114, of which 23,905 pounds, valued at \$679, were salted. There was a decrease of 41.51 per cent in the quantity of cusk landed, but the value was only slightly less than that of the previous year.

Halibut.—The yield of halibut was 1,766,064 pounds, valued at \$219,232. This quantity included 42,364 pounds of salted halibut, valued at \$3,604. There was a decline in the output of halibut, as compared with the previous year of 48.93 per cent in quantity and 43.14 per cent in value.

Mackerel.—The total catch of fresh mackerel taken by the American fishing fleet in 1917 amounted to 111,932 barrels, compared with 102,420 barrels the previous year, an increase of 9,512 barrels. The output of salted mackerel was 32,162 barrels, as compared with 32,066 barrels the previous year, an increase of 96 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland during the year was 17,442,063 pounds, valued at \$1,454,119, of which 12,031,817 pounds, valued at \$867,557, were fresh, and 5,410,246 pounds, valued at \$586,562, were salted.

In 1918, up to June 30, the catch of fresh mackerel amounted to 27,992 barrels and of salted mackerel to 7,937 barrels, as compared with 38,947 barrels fresh and 7,131 barrels salted the previous year. The southern mackerel fleet numbered about 35 sail of seiners and 125 sail of netters. The seiners had a light catch, and reported considerable quantities of mackerel, but that they were wild, chasing live feed, and therefore hard to catch. They did not school much at night, but only during the day. The first seiner arrived at New York on May 6 with 13,000 large and medium mackerel, which were sold at 18 to 20 cents per pound. These fish were taken in 34 fathoms of water. The netters did not land as many mackerel as the previous year, but, owing to the higher prices received, they did well financially. The mackerel landed by the southern fleet this year were all large and medium fish and sold at 13 to 20 cents per pound,

according to market conditions. The Cape Shore fleet numbered 38 sail of vessels, being a little larger than the previous year. No vessel made more than one trip. A large body of fish was reported and all the vessels returned with good catches. The catch taken on the Cape Shore amounted to 1,689,000 pounds of fresh mackerel, and 7,558 barrels salted, compared with 2,229,900 pounds of fresh and 7,131 barrels salted the previous year. The first arrival from the Cape Shore was on June 8, and consisted of 50,000 large and medium fresh mackerel, which sold at 10½ cents per pound. One schooner, on her Cape Shore mackerel trip, obtained 95,000 pounds fresh and 375 barrels of salted mackerel, and stocked \$15,665, the crew sharing \$343 each. This is said to be the largest stock ever made on a single mackerel trip.

Swordfish.—The catch of swordfish landed at Boston, Gloucester, and Portland during the year amounted to 1,973,518 pounds, valued at \$292,169. The number of vessels engaged in this fishery was 42, or 9 more than in the previous year.

Flounders.—The catch of flounders in the vessel fisheries amounted to 1,279,721 pounds, valued at \$44,936. The catch taken by vessels under 5 tons net tonnage is not included in these statistics. These fish are taken chiefly with the flounder drag, an apparatus similar to an otter trawl, and adapted for use in this fishery. This apparatus is used by power vessels and boats. It varies in size according to the size of the vessel or boat using it. The foot line or chain varies in the different sizes of nets from about 48 to 70 feet in length. When being set the drag is thrown overboard from the stern of the boat, and the foot line, or chain, carries it quickly to the bottom. In the meantime the boat is under power, and when the water strikes the drag the bag or net is opened. As the boat moves forward two otter boards, or wooden doors, one at each end of the foot line, or chain, operate to spread the bag out to its full extent. The apparatus is drawn along the bottom by the vessel or boat for about two hours, and then it is taken on board and the fish are dumped out.

The Massachusetts fishermen have been catching during the past year, apparently for the first time in commercial quantities, a fish which is locally called sole or gray sole. This species, which has been identified as the pole flounder, craig flounder, or deep-sea flounder (*Glyptocephalus cynoglossus*), is found on both shores of the Atlantic Ocean, ranging as far south as Ireland and Delaware Bay in deep water. It was first found on our coast in 1877, when numerous specimens were secured by the Bureau in the deepest parts of Massachusetts Bay. It is an excellent food fish, and large quantities were taken in the fall of 1917 and also during the year 1918.

VESSEL FISHERIES AT SEATTLE, WASH.

The vessel fisheries at Seattle, Wash., have not varied materially in extent from the previous year. The products landed by fishing vessels have been smaller in quantity, but have increased in value. In the products landed by collecting vessels there has been considerable increase in both quantity and value. Statistics of the vessel fisheries at Seattle have been collected by the local agent and pub-

lished as monthly and annual statistical bulletins, giving the quantity of fishery products landed by American fishing vessels at that port.

In 1917 the fishing fleet at Seattle landed at that port 620 trips, aggregating 16,553,944 pounds of fish, having a value to the fishermen of \$1,738,802. This catch was taken from the various fishing grounds along the coast from off the Columbia River northward to Portlock Bank, Alaska. The localities from which the largest quantities of fish were taken were the Destruction Island Grounds, Flatery Banks, Hecate Strait, Yakutat Grounds, and Portlock Bank. The products included halibut, 13,949,683 pounds, valued at \$1,625,409; sablefish or black cod, 2,430,105 pounds, valued at \$107,350; and other species amounting to 174,156 pounds, valued at \$6,043.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 12,821,353 pounds, valued at \$988,559. The products included salmon, 10,869,193 pounds, valued at \$935,915; steelhead trout, 165,024 pounds, valued at \$16,233; herring, 1,211,224 pounds, valued at \$6,393; smelt, 211,799 pounds, valued at \$13,004; and other fishery products amounting to 364,118 pounds, valued at \$17,014. These products included 3,909 pounds of whale meat, valued at \$195.

Compared with the previous year there was an increase of 103 trips by fishing vessels, with a decrease of 857,491 pounds, or 4.92 per cent, in the quantity, and an increase of \$377,569, or 27.73 per cent, in the value of the products landed. In the products landed by collecting vessels there was an increase of 2,683,966 pounds, or 26.47 per cent, in the quantity, and of \$517,300, or 109.76 per cent, in the value. The quantity and value of fishery products landed at Seattle by fishing and collecting vessels in 1917 are given in detail in the following table:

QUANTITIES AND VALUES OF CERTAIN FRESH FISHERY PRODUCTS LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS DURING THE CALENDAR YEAR 1917.

BY FISHING GROUNDS.

	Num- ber of trips.	Halibut.		Cod.		Sablefish (black cod).		"Lingcod."		Red rockfish.		Herring.		Total.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Columbia River grounds.....	25	605,000	\$84,283	.....	.....	267,500	\$10,900	.....	.....	.....	.....	.....	.....	872,500	\$75,183
Grays Harbor grounds.....	7	90,500	14,516	.....	.....	149,500	6,485	.....	.....	.....	.....	.....	.....	240,000	20,961
Destruction Island grounds.....	32	661,000	65,761	.....	.....	413,000	16,520	.....	.....	.....	.....	.....	.....	1,074,000	82,281
Flattery Banks.....	245	2,099,400	228,595	.....	.....	873,700	42,281	23,000	\$460	.....	.....	.....	.....	2,996,100	271,336
West coast, Vancouver Island.....	65	610,900	90,992	.....	.....	301,400	14,422	60,000	2,400	.....	.....	.....	.....	985,300	109,265
Cape Scott grounds.....	38	590,000	59,178	.....	.....	4,000	160	.....	.....	.....	.....	.....	.....	594,000	59,963
Hecate Strait.....	83	2,254,600	307,066	.....	.....	176,000	7,180	.....	.....	.....	.....	.....	.....	2,430,600	314,266
Noyes Island.....	7	72,000	7,043	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	72,000	7,043
Coronation Island.....	28	806,200	80,176	.....	.....	13,870	402	.....	.....	.....	.....	.....	.....	820,070	80,578
Cape Spencer.....	3	130,000	13,490	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	130,000	13,490
Yakutat grounds.....	44	3,183,153	346,528	.....	.....	118,540	3,676	274	6	24,132	631	.....	.....	3,296,104	350,841
Yakutat grounds.....	2	100,000	16,000	.....	.....	1,000	50	.....	.....	.....	.....	.....	.....	100,000	16,000
Cape Cleare grounds.....	1	34,725	4,176	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,725	4,226
Portlock Bank.....	39	2,742,200	325,630	.....	.....	15,000	\$226	8,500	253	29,250	586	.....	.....	2,906,545	332,019
Total.....	620	13,949,683	1,625,409	15,000	226	2,480,105	107,350	91,774	3,119	59,382	1,438	8,000	1,260	16,538,944	1,738,802

BY MONTHS.

January.....	13	751,702	\$87,978	.....	.....	73,870	\$1,825	.....	.....	.....	.....	.....	.....	825,572	\$89,803
February.....	7	296,548	35,464	.....	.....	19,720	545	.....	.....	.....	.....	.....	.....	316,268	36,009
March.....	44	1,583,330	126,380	.....	.....	63,680	2,304	164	84	3,266	583	.....	.....	1,647,280	133,681
April.....	85	1,327,200	140,940	.....	.....	60,300	2,362	.....	.....	5,596	153	.....	.....	1,393,096	143,368
May.....	146	2,540,500	237,945	.....	.....	330,400	12,801	.....	.....	2,200	66	.....	.....	2,871,160	250,971
June.....	114	2,038,600	204,440	.....	.....	498,000	19,840	33,000	460	10,250	205	.....	.....	2,537,600	224,749
July.....	34	1,082,000	121,852	15,000	\$226	270,000	10,800	150	3	13,600	273	.....	.....	1,366,750	137,884
August.....	40	1,183,800	138,826	.....	.....	208,500	8,260	.....	.....	.....	.....	.....	.....	1,392,300	147,086
September.....	37	1,059,600	146,223	.....	.....	380,000	15,905	.....	.....	6,400	133	.....	.....	1,443,000	152,261
October.....	46	1,014,700	162,482	.....	.....	376,683	23,485	.....	.....	.....	.....	8,000	31,260	1,396,368	157,267
November.....	27	843,438	62,810	.....	.....	96,880	6,085	90	3	11,100	245	.....	.....	1,369,395	157,267
December.....	27	831,300	131,181	.....	.....	66,050	3,086	83,350	2,650	7,000	252	.....	.....	973,700	99,255
Total.....	620	13,949,683	1,625,409	15,000	226	2,480,105	107,350	91,774	3,119	59,382	1,438	8,000	1,260	16,538,944	1,738,802

FISHERY PRODUCTS, BY MONTHS, TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS DURING 1917.

Species.	January.		February.		March.		April.		May.		June.		July.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Grayfish.....														
Sturgeon.....														
Starling.....	2,000	\$30	350,324	\$1,797	220	\$11			2,205	\$158	3,100	\$155	1,000	\$65
Shad.....					739,960	3,700			100,950	896				
Salmon:									7,600	380				
Rumpback or pink.													23,850	477
Kum or keta.	2,860	157											9,120	273
King or spring.	200	22	318	27	132	7	8,400	\$773	229,566	17,773	325,180	24,460	497,165	84,801
Coho or silver.	80	3	50	2							67,190	5,375	34,000	2,040
Sockeye or red.									1,900	160	19,280	1,345	41,830	3,346
Trawl:														
Beelhead														
Salmon.	24,687	2,716	28,330	2,723					14,380	1,135	24,000	1,920	11,650	600
Smelt.	3,000	90	5,504	460	5,632	710	7,358	637	20,208	1,066	17,000	1,360		
Perch.			2,000	100	3,205	128	4,200	210		25	2,400	134		
Red rockfish.			27	1	2,141	112								
"Kinged".	660	33	1,021	41	2,514	131	1,500	28	18,000	270	6,000	150	3,620	92
Founders.	1,000	30	17,000	270	10,236	586							3,620	63
Cod.			2,350	35	2,600	39	500	8	4,700	71	6,400	128	960	14
Sole.	1,425	21	9,040	249	9,051	272	2,500	63	2,200	38	8,000	320		
Other fish.													3,065	92
Whale meat.									3,909	166				
Crabs.	6,394	287	4,100	238	2,000	100	1,320	160	2,076	400				
Clams.					12,900	139	4,000	50	3,105	34				
Total.....	45,271	3,474	423,634	6,413	791,631	5,844	29,808	1,919	422,268	22,530	479,500	35,347	629,840	41,960

Species.	August.		September.		October.		November.		December.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Grayfish.....	1,000	\$10			385	\$30					1,000	\$10
Sturgeon.....	2,000	80	2,200	\$132							11,180	599
Herring.....											1,211,224	6,383
Shad.....											7,000	380
Salmon:												
Humpback or pink.....	1,090,530	28,354	338,700	38,670	1,791	179			158,780	\$16,466	1,502,871	98,690
Chum or keta.....	120,638	6,032	448,880	22,445	3,795,630	379,563			20,634	2,043	5,406,416	481,805
King or spring.....	427,100	25,628	137,060	12,335	51,455	4,631	15,840	1,584			1,713,799	124,081
Coho or silver.....	123,335	2,745	385,856	39,896	978,808	146,531	64,260	8,158	2,340	224	1,663,889	204,664
Bockeye or red.....	223,990	22,389	287,030	28,763	7,668	766					1,582,218	86,686
Trout:												
Steelhead.....	1,720	190	21,880	2,188	9,944	885	233	21	31,220	3,746	165,024	16,223
Salmon.....											85,782	4,423
Smelt.....			10,000	800	60,114	4,809	37,820	4,390	39,060	2,343	211,799	13,004
P perch.....			4,000	80							7,047	194
Red rockfish.....			520	10	135	4					9,666	521
"Lingcod".....	1,500	16	1,265	25							37,320	753
Cod.....											22,735	778
Flounders.....	700	7	3,100	62							22,236	385
Sole.....			2,000	80			2,246	44	3,060	124	41,172	1,275
Other fish.....	4,400	308	1,464	59					44,000	1,320	52,929	1,779
Whale meat.....											3,909	165
Crabs.....											71,632	5,582
Clams.....							26,662	2,430	29,150	1,977	20,005	213
Total.....	1,996,821	86,756	1,702,565	145,235	4,903,960	537,314	1,068,001	73,514	323,054	28,263	12,821,383	983,559

* 3,965 dozen.

COASTAL FISHERIES OF NEW YORK AND NEW JERSEY.

A statistical canvass of the coastal fisheries of New York and New Jersey was made during the year for the calendar year 1917 similar to the previous canvass of these fisheries for the year 1915. The statistics included only fishes proper.

In New York there were 1,538 persons engaged in the coastal fisheries, exclusive of shellfish, in 1917; the investment in vessels, boats, fishing apparatus, and shore and accessory property was \$1,370,823; and the products amounted to 68,315,888 pounds, valued at \$1,376,360. The principal species taken were alewives, 788,875 pounds, valued at \$14,617; bluefish, 961,340 pounds, valued at \$183,136; butterfish, 800,499 pounds, valued at \$47,979; flounders, 4,176,374 pounds, valued at \$180,333; menhaden, 50,441,540 pounds, valued at \$261,919; scup or porgy, 1,212,650 pounds, valued at \$72,217; sea bass, 1,122,623 pounds, valued at \$81,654; squeteague or weakfish, 2,292,050 pounds, valued at \$170,861; tilefish, 1,480,828 pounds, valued at \$100,551; and whiting, 1,488,800 pounds, valued at \$33,510. The menhaden were caught chiefly in southern waters and landed at southern ports, but are properly credited to New York because taken by vessels belonging in that State.

Compared with the returns for 1915, there was a decrease of 966, or 38.5 per cent, in the number of persons engaged, and of \$400,343, or 22.6 per cent, in the amount of capital invested; but an increase of 34,268,113 pounds, or 100.6 per cent, in the quantity, and of \$254,719, or 22.7 per cent, in the value of the products. If the menhaden are excluded for both years, a decrease is shown in the quantity of all other fish of 1,654,615 pounds, or 8.4 per cent, and an increase in the value of \$93,735, or 9.18 per cent.

In New Jersey in 1917 there were 2,137 persons engaged in the coastal fisheries for fishes proper; the investment in vessels, boats, fishing apparatus, and shore and accessory property was \$1,235,550; and the products amounted to 49,979,375 pounds, valued at \$1,953,076. The species taken in largest quantities were alewives, 2,051,172 pounds, valued at \$28,746; bluefish, 1,122,158 pounds, valued at \$150,605; butterfish, 4,227,745 pounds, valued at \$200,564; croaker, 3,483,095 pounds, valued at \$142,811; flounders, 1,369,848 pounds, valued at \$85,643; hake, 2,092,195 pounds, valued at \$27,338; menhaden, 1,433,984 pounds, valued at \$14,664; scup or porgy, 3,673,173 pounds, valued at \$137,004; sea bass, 5,323,116 pounds, valued at \$313,137; squeteague or weakfish, 11,004,255 pounds, valued at \$482,916; and whiting, 10,401,255 pounds, valued at \$135,188.

Compared with 1915 there was a decrease of 166, or 7.2 per cent, in the number of persons engaged; an increase of \$43,493, or 3.6 per cent, in the investment; of 2,123,199 pounds, or 4.4 per cent, in the quantity; and \$604,409, or 44.8 per cent, in the value of the products. Excluding the menhaden for both years, there was an increase in 1917 in the quantity of all other fish of 5,044,004 pounds, or 11.59 per cent, and in the value of \$626,347, or 47.73 per cent.

The statistics of these fisheries, by counties, are given in the following table:

COASTAL FISHERIES OF NEW YORK AND NEW JERSEY, BY COUNTIES, EXCLUSIVE OF SHELLFISH, 1917.

Items.	New York.						New Jersey.											
	Nassau.			New York and Richmond.			Suffolk.			Total.			Atlantic.			Burlington.		
	Number.	Value.	Pounds.	Number.	Value.	Pounds.	Number.	Value.	Pounds.	Number.	Value.	Pounds.	Number.	Value.	Pounds.	Number.	Value.	Pounds.
Persons engaged.	74			650			814			1,538			262			36		
Vessels fishing.	2	\$2,500		41	\$487,460		60	\$87,480		108	\$587,360		19	\$66,200		108		
Tonnage.	15			2,171			563			2,749			301					
Outfit.		200			200,708		29	19,075			200,671			40,126				
Vessels transporting.	2	2,000					22	56,960		31	58,960							
Tonnage.	17						223			339								
Outfit.		90						5,516			5,608							
Sail, row and house-boats.	16	660					410	16,548		426	17,108		47	1,140		21		\$350
Gasoline boats.	18	7,960		1	800		283	104,000		261	112,750		27	10,650		5		400
Pound nets.	1	4,000			800		468	141,265		487	146,065		1	1,600				
Fyke nets.	7	610		31	84,200		96	13,176		133	47,996		35	7,330		6		226
Gill nets.	181	4,880		160	3,400		689	15,980		890	22,430		71	10,125		23		860
Fyke nets.							4,063	22,452		4,053	22,452		6					
Bag nets.													24	680		59		1,535
Dip nets.							6			6								
Lines.		420			7,360			756			8,426			8,190				
Otter trawls.	3	90					226	6,965		228	8,065		1	120				
Kel pots.	223	263					4,503	4,923		4,735	5,205		85	155				
Other apparatus.		\$2,959									3,009							
Shore and accessory property.		1,460						74,326			76,775			7,910				250
Total.		27,571			773,316			560,936			1,370,823			149,367				3,220
PRODUCTS.																		
Albacore and horse mackerel.	6,500	\$250		801	\$38		3,560	\$136		10,581	\$473							
Salvies.	10,800	434		5,000	150		773,073	14,043		788,875	14,617		13,578	\$370				
Shad.	8,800	1,960		869,511	165,011		83,029	16,135		961,540	185,186		261,530	\$2,328				
Shad.	2,060			8,067	1,267		53,029	3,021		77,201	9,568		6,175	55				
Batterfish.	22,060	1,264					773,446	46,726		800,496	47,979			47				
Carp.							122,000	15,234		122,000	15,234							
Cod.	4,000	400		300,830	25,267		45,906	4,260		354,586	27,966		47,000	3,833				
Crab.				7,026	281					7,026	281		42,873	17,188				
Drum.													560					
Reds, fresh.	26,000	2,525		6,248	326		383,366	42,342		415,977	45,493		13,865	1,006				
Reds, salt.	68,940	3,261		3,863	449		4,102,369	176,653		4,176,514	180,333		58,907	3,567		875		\$75
Graydon.	2,430	70		2,775	2,136		30,319	813		24,775	2,136		4,600	85				
Headstock.																		

* Includes 1,950 sea-bass pots, valued at \$2,928.

* No fisheries were operated in Kings and Queens counties in 1917.

COASTAL FISHERIES OF NEW YORK AND NEW JERSEY, BY COUNTIES, EXCLUSIVE OF SHELLFISH, 1917—Continued.

Items.	New York.				New Jersey.			
	Nassau.		New York and Richmond.		Suffolk.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.								
Bake.....	6,520	\$286			46,076	\$1,108	66,562	\$1,964
Berring.....					291,700	8,143	291,700	8,143
Clupea.....	200	50			23,912	3,960	24,112	6,740
Macrel.....	35,320	4,310	25,600	3,150	501,225	86,866	562,045	43,836
Menaden.....	1,200	26	45,304,800	220,440	5,135,540	11,464	201,919	9,700
Mullet, fresh.....					250	13	250	13
Mummichog.....					221,100	2,015	221,100	2,015
Pike.....					110,975	6,266	279,451	14,725
Pollack.....	2,150	223	168,779	8,469	519,663	29,914	1,312,650	72,217
Scup or porgy.....	100,800	9,464	462,488	42,060	567,464	46,112	1,122,625	81,654
Sea bass.....	3,500	70	396,339	28,868	179,690	2,441	101,930	2,216
Sea robins.....			2,160	306	13,467	2,468	20,527	2,462
Shad.....	1,540	37	5,438	191	127,750	2,968	184,086	2,299
Shad and rays.....	880	17			16,662	3,048	17,542	4,173
Small.....	100	25			388	70	1,357	60
Spanish mackerel.....	150	33			787	46	1,400	94
Spot.....	38,790	3,383	470,000	27,000	1,783,270	140,098	2,392,050	170,881
Spot or weakfish.....	6,160	3,185			899,500	10,688	406,960	11,173
Striped bass.....	5,200	1,815			19,267	4,813	6,733	8
Sturgeon.....	220	35			17,524	3,740	5,435	880
Sturgeon caviar.....					175	437	17,175	4,437
Swordfish.....					2,000	240	2,000	189
Tautog.....	220	18			118,812	8,686	119,032	240
Thick.....					1,480,828	100,561	1,480,828	17,200
Tomcod.....					20,267	1,314	20,267	1,314
Whitebait.....					69,700	4,937	99,700	4,937
White perch.....					17,175	1,919	17,175	1,919
Whiting.....	89,800	2,245			1,309,000	31,265	1,468,800	33,510
Yellow perch.....					1,580	163	1,580	14
Other fish.....							6,365	385
Total.....	505,800	33,318	49,770,468	694,799	18,093,820	718,273	68,315,888	1,376,380
							4,158,996	294,064
								27,805
								3,221

COASTAL FISHERIES OF NEW YORK AND NEW JERSEY, BY COUNTIES, EXCLUSIVE OF SHELLFISH, 1917—Continued.

New Jersey.

Items.	Cape May.		Hudson.		Middlesex.		Monmouth.		Ocean.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
PRODUCTS—continued.												
Herring.....	10,208	\$1,213					27,455	\$322			27,455	\$322
Blocky shad.....	210,065	24,436					8,787	372			8,787	372
Kingfish.....	200,997	2,436					3,849	381			3,849	381
Mackerel.....	5,060				30,000	\$50	51,895	6,212	4,100	\$467	57,000	6,679
Menhaden.....	5,060						987,208	10,076	205,991	1,877	1,193,199	14,953
Mullet, fresh.....												
Mullet, salted.....												
Pike.....	33,250	315										
Pollock.....							1,676	64	5,685	108	40,611	517
Round herring.....	2,553,108	95,710					92,277	3,612			92,277	3,612
Scup or porcy.....	3,553,112	199,968	460	\$50			91,918	4,612	225,357	14,119	3,673,173	137,004
Sea bass.....	2,850	21	2,200	320			173,998	13,425	768,708	57,529	5,323,116	313,137
Sea robins.....							31,639	452	8,800	102	43,289	505
Shad.....	1,100	191					11,794	2,538	1,388	262	14,282	3,021
Sharks.....	21,460	394					38,225	602	32,500	550	106,654	1,705
Silveride.....							1,326	25			1,326	25
Skates and rays.....	19,373	317					207,216	1,803	49,100	595	256,691	2,885
Snail.....	1,685				7,100	2,050					7,100	2,050
Spanish mackerel.....	12,715	598					438	70	4,950	768	7,083	1,072
Spot.....	4,475,717	167,002	650	75	89,700	4,650	140,298	3,013	134,700	2,365	289,322	6,070
Squeteague or weakfish.....	57,776	1,240					2,119,538	126,445	3,033,238	135,297	11,004,255	452,916
Squid.....							185,950	3,612	447,064	7,177	633,014	12,337
Striped bass.....	4,005	650					1,475	290	2,645	555	11,622	2,381
Sturgeon.....	285						4,180	436	9,000	112	9,382	1,248
Sturgeon caviar.....							57	111	50	100	3,175	189
Suckers.....							10,125	58			10,125	58
Swellfish.....	150						44,413	3,009	10,000	900	56,768	4,235
Tartar.....			2,200	320							257,000	17,200
Weakfish.....					600	50					2,135	155
Wormed.....							455	45			1,300	40
Whitebelly.....	2,075	278					1,800	40			365,999	41,208
White perch.....	237,384	5,358					460	40	337,205	36,443	10,401,255	135,188
Whiting.....							5,157,788	61,716	4,914,378	68,100	10,401,255	135,188
Yellow perch.....	1,800	70					41	20			1,860	120
Other fish.....											6,946	446
Total.....	16,064,075	737,776	46,413	4,846	143,775	8,260	12,896,234	410,637	16,069,477	547,302	49,979,375	1,685,076

FISHING ON FIVE-FATHOM BANK, NEW JERSEY, IN 1916 AND 1917.

For several years a considerable number of pound nets have been set on Five-Fathom Bank, lying about 10 miles off the coast of southern New Jersey. The Bureau has collected statistics of this fishery for 1916 and 1917. The information for 1917 is included in the foregoing statistics of the coastal fisheries of New Jersey for that year.

In 1916 there were 120 persons engaged in fishing pound nets or Five-Fathom Bank. The number of pound nets operated was 14, valued at \$44,550; the number of boats used was 19, valued at \$18,625; and the shore and accessory property was valued at \$78,400; a total investment of \$141,575. The products amounted to 3,224,140 pounds, valued at \$133,612.

In 1917 there were 183 persons engaged in the fishery; the number of pound nets fished was 21, valued at \$72,322; the boats numbered 27, valued at \$25,900; and the shore and accessory property was valued at \$104,250; a total investment of \$202,472. The products aggregated 4,828,620 pounds, valued at \$231,695.

The principal species of fish taken in each of these years were scup or porgy, sea bass, and squeteague or weakfish. Butterfish, croaker, flounders, mackerel, and various other species were also taken in considerable quantities.

Statistics of this fishery in 1916 and 1917 are given in the following table:

FISHING ON FIVE-FATHOM BANK, N. J., IN 1916 AND 1917.

Items.	1916		1917	
	Number.	Value.	Number.	Value.
Fishermen.....	98		149	
Shoemen.....	22		34	
Pound nets.....	14	\$44,550	21	\$72,322
Gasoline boats.....	18	18,600	26	25,900
Other boats.....	1	25	2	50
Shore and accessory property.....		78,400		104,250
Total investment.....		141,575		202,472
PRODUCTS.				
	Pounds.	Value.	Pounds.	Value.
Butterfish.....	52,420	\$2,390	219,621	\$10,533
Croaker.....	72,460	2,202	200,513	7,822
Flounders.....	25,760	1,024	93,052	4,460
Mackerel.....	2,700	270	8,800	889
Scup or porgy.....	905,480	32,617	1,080,200	45,168
Sea bass.....	1,432,435	61,735	2,041,466	112,499
Squeteague or weakfish.....	618,040	30,193	1,034,969	46,211
Whiting.....	2,260	30	28,426	425
Other fish.....	66,295	2,320	79,005	2,800
Squid.....	46,200	841	42,584	842
Total.....	3,224,140	133,612	4,828,620	231,695

SHAD FISHERY OF THE HUDSON RIVER.

In connection with the canvass of the coastal fisheries of New York and New Jersey, statistics were obtained of the shad fishery of the Hudson River for the years 1917 and 1918. In 1918 there were 227 fishermen engaged in this fishery, using 125 boats, valued at \$4,790; 273 gill nets, valued at \$10,756; 15 seines, valued at \$1,370; and shore and accessory property valued at \$3,191; a total investment of \$20,107. The catch of shad was much larger than in any of the three preceding years, amounting to 67,403 in number, or 234,602 pounds, valued at \$48,184. Of this quantity 63,404 shad, or 220,602 pounds, valued at \$44,784, were taken on the New York side of the river, and 3,999 shad, or 14,000 pounds, valued at \$3,400, were taken on the New Jersey side. In 1915 the total catch of shad in this river in both States was 15,855 fish, or 68,668 pounds, valued at \$8,643; in 1916, 9,287 fish, or 40,173 pounds, valued at \$5,465; and in 1917, 12,015 fish, or 43,384 pounds, valued at \$6,540. The catch each year was taken chiefly with gill nets.

SHAD FISHERY OF THE HUDSON RIVER, 1917 AND 1918.*

1917

Items.	New York.			New Jersey.			Total.		
	Number.	Pounds.	Value.	Number.	Pounds.	Value.	Number.	Pounds.	Value.
Fishermen.....	141			8			149		
Rowboats.....	70		\$8,940	4		\$130	74		\$8,070
Gasoline.....	1		200	1		300	2		500
Gill nets.....	213		6,500	2		700	215		7,200
Seines.....	13		1,135				13		1,135
Shore and accessory property.....			1,340			1,350			2,690
Total.....			12,115			2,480			14,595
Shad caught:									
With gill nets ..	9,535	34,420	5,225	1,400	5,040	720	10,935	39,460	5,955
With seines.....	1,080	3,924	585				1,080	3,924	585
Total.....	10,615	38,344	5,810	1,400	5,040	720	12,015	43,384	6,540

1918

Fishermen.....	224			3			227		
Rowboats.....	122		\$4,240	1		\$100	123		\$4,340
Gasoline.....	1		250	1		200	2		450
Gill nets.....	272		10,458	1		300	273		10,758
Seines.....	15		1,370				15		1,370
Shore and accessory property.....			2,241			950			3,191
Total.....			18,557			1,550			20,107
Shad caught:									
With gill nets ..	61,583	214,196	43,413	3,999	14,000	3,400	65,582	228,196	46,813
With seines.....	1,821	6,406	1,371				1,821	6,406	1,371
Total.....	63,404	220,602	44,784	3,999	14,000	3,400	67,403	234,602	48,184

* Includes Columbia, Dutchess, Greene, Orange, Rockland, Ulster, and Westchester Counties in New York; and Bergen and Hudson Counties in 1917, and Bergen County in 1918, in New Jersey.

STATISTICS OF THE WHOLESALE FRESH-FISH TRADE OF NEW YORK CITY.

Beginning with September 1, 1917, the Bureau undertook the collection of statistics showing by species the quantities and value of fresh fish handled by the wholesale trade of New York City. This was initiated as an experiment to determine the practicability of carrying on this work continuously as at Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., and the value of the information to the trade. Statistics were collected for the five months ending January 31, 1918. This afforded ample opportunity for a careful study of the local conditions. The complex nature of shipments received by the wholesale trade made it exceedingly difficult for the dealers to furnish complete returns, and entailed a considerable burden on their clerical force. For these reasons and because of the apathetic attitude of the trade toward the work, the Bureau decided to discontinue the collection of these statistics for the time being.

Statistics of the wholesale fresh-fish trade of New York City from September, 1917, to January, 1918, inclusive, are given in the following table:

FRESH FISH HANDLED BY THE WHOLESALE FISH TRADE OF NEW YORK CITY FROM SEPTEMBER, 1917, TO JANUARY, 1918.

Species.	September.		October.		November.		December.		January.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Albacore or horse mackerel.....	15,884	\$1,312	6,053	\$561	9,714	\$619	89	\$8	385	\$29
Amberfish.....	350	11	492	35	2,150	12	2,800	250	202	25
Anchovies.....	1,938	126	35	35	100	12	107	5	202	25
Angelfish or spadefish.....	198,960	47,715	354,238	73,424	27,320	8,481	32,037	10,321	194,511	47,261
Barracuda.....	37,073	5,868	8,520	1,376	27,320	8,481	930	71	194,511	47,261
Blue runner.....	50,208	3,098	66,268	4,296	80,416	5,269	33,588	2,738	31,444	3,086
Bowfin.....	70,890	9,045	11,480	4,296	254,239	31,444	202,267	30,915	311,578	54,860
Butterfish.....	277,871	31,389	241,672	30,051	34,947	6,547	1,265	313	78,487	8,866
Butterfish.....	1,191,555	135,021	967,584	99,454	877,585	91,224	674,538	74,498	478,718	78,043
Carp.....	11,355	1,304	4,718	907,584	9,079	1,473	175,524	28,818	1,405	203
Catfish and bullheads.....	1,244,905	180,672	1,019,811	107,147	11,889	2,047	100,199	15,968	188,263	28,689
Channel bass.....	951,109	98,276	1,049,335	109,824	1,026,457	139,770	628,910	51,540	115,532	10,970
Cisco or lake herring.....	191,075	14,384	119,036	9,938	1,069,262	120,367	1,171,568	186,585	1,036,311	135,947
Croaker.....	1,111	58	931	28	109,435	9,729	3,388	270	346	21
Cunner.....	5,338	261	10,499	603	6,271	315	3,636	337	181	19
Cook.....	13,068	489	26,657	5,348	5,348	332	2,402	105	31,211	2,375
Drum, black.....	245,068	26,657	283,724	24,567	121,678	15,754	8,741	641	15,096	1,388
Eel.....	943,280	55,409	1,545,985	119,407	1,832,064	115,534	298,659	48,881	48,201	6,345
Eel, conger.....	180	16	16	6	1,832,064	115,534	4,574	171	20,538	924
Flounders.....	191,075	14,384	119,036	9,938	1,832,064	115,534	1,683,778	124,107	763,110	74,821
Gardiner.....	1,244,905	180,672	1,019,811	107,147	1,832,064	115,534	200	8	763,110	74,821
Gooselish.....	191,075	14,384	119,036	9,938	768	29	1,919	183	10	10
Grayfish.....	221,603	15,004	219,929	17,137	7,900	173	1,284	87	240	105
Groupers.....	265,635	17,497	366,020	16,248	2,573	232	1,284	87	240	105
Haddock.....	327,878	22,760	196,899	43,756	182,490	17,569	337,871	673	288,822	27,070
Hake.....	473,868	22,760	450,354	18,383	683,441	21,804	337,871	673	288,822	27,070
Hallibut.....	22,760	22,760	450,354	18,383	186,670	42,842	235,559	5,062	12,639	1,260
Herring, sea.....	191,075	14,384	119,036	9,938	396,201	17,711	140,979	8,946	216,390	45,041
Hickory shad.....	191,075	14,384	119,036	9,938	396,201	17,711	140,979	8,946	216,390	45,041
Hogfish or pigfish.....	191,075	14,384	119,036	9,938	396,201	17,711	140,979	8,946	216,390	45,041
Jackfish.....	191,075	14,384	119,036	9,938	396,201	17,711	140,979	8,946	216,390	45,041
Kingfish.....	191,075	14,384	119,036	9,938	396,201	17,711	140,979	8,946	216,390	45,041
Macarel.....	826,628	107,715	670,245	4,535	26,400	2,031	1,871	187	1,270	156
Macarel, Spanish.....	16,827	8,427	24,085	104,043	49,831	6,079	21,974	3,532	5,023	63
Menhaden.....	20,838	8,427	24,085	104,043	178,584	18,949	105,576	15,945	2,793	1,260
Mud shad.....	1,219	123	34,184	3,643	1,580	35,672	371,909	70,857	475,792	73,367
Mullet.....	1,219	123	34,184	3,643	1,580	35,672	371,909	70,857	475,792	73,367
Mummichog.....	4,419	621	5,687	743	72,759	8,816	3,979	108	2,426	673
Perch, white.....	4,419	621	5,687	743	60,440	8,480	42,387	3,789	45,740	4,417
							30,581	8,676	688	6,184

Perch, yellow.	148,087	21,346	141,154	19,849	141,494	17,919	40,209	7,576	24,333	6,889
Perch, or grass pike.	118,136	19,089	111,832	118,104	177,768	11,600	66,443	19,307	25,336	6,635
Pike perch (blue, yellow, or wall-eyed).	246,706	62,963	266,292	62,378	177,264	37,671	86,443	7,460	40,796	12,383
Pikefish.					436	38				
Pollack.	342,944	27,530	1,009,504	62,933	689,092	46,476	789,781	58,325	108,053	12,441
Pompano.	1,072	2,420	2,812	62,580	4,108	1,146	6,284	1,761	12,539	4,002
Salmon:										
Atlantic.	12,060	2,287	5,242	1,044					7,435	1,672
Blueback.			2,042							
Chinook.	34,135	6,897	18,557	3,086	287	73				
Chum.	35,767	3,952	108,672	10,980	112,402	17,824			45,032	6,377
Kumpback.	6,000	660								
Silver.			125,166	26,418	103,968	19,366	6,723	1,966	57,182	10,399
Steelhead.	44,475	1,681	7,880	184	6,150	27	23,176	7,587	31,551	7,182
Scup or porgy.	99,522	10,632	31,539	3,203	6,850	1,069	1,512	1,90	163	19
Sea bass.	184,944	27,830	67,500	13,680	99,915	15,364	73,735	13,976	60,410	10,793
Sea robin.	37,113	1,053	12,473	274					6,450	13
Sergeantfish.										
Shad.	176	8	161	35	12,400	214	23,841	7,769	40,214	10,981
Sharks.	17,190	556	9,208	322	6,639	303	1,019	90	1,799	58
Sheepshead or fresh-water drum.	24,008	2,170	29,721	2,947	6,841	483	2,972	249	22,104	2,880
Sheepshead, salt-water.			5,960	646	10,984	1,379	16,335	2,622	1,366	
Silveride or spearing.	17,509	990	27,803	1,410	29,861	2,206	14,323	807	1,315	77
Skates.	15,453	586	37,759	1,113	35,901	1,303	22,753	1,083	25,307	1,271
Small.	12,561	1,911	166,867	26,107	274,269	55,074	482,076	90,668	534,168	104,515
Snapper, red.			11,796	73	11,796	1,584	6,455	1,110	6,775	1,387
Snapper, other.			552	69	2,117	1,387				
Spoonbill, etc.			14,009	2,632	15,404	3,196	25,859	6,981	11,931	2,781
Spot or Ladyette.	53,994	2,578	117,731	4,085	23,319	2,028	6,469	6,707	45,250	4,349
Squeteague or weakfish.	759,080	96,994	697,986	82,642	412,409	65,694	123,534	24,773	186,579	27,771
Squid.	168,248	11,063	147,154	9,133	129,225	6,403	20,741	1,081	81,796	4,046
Striped bass.	6,263	2,418	60,827	11,308	65,801	16,436	65,288	17,247	21,537	6,921
Sturgeon.	9,834	1,616	39,768	11,700	20,256	5,698	1,732	449	1,887	174
Stuckers.	251,444	27,753	233,963	26,524	180,621	19,159	185,630	23,831	124,558	18,715
Sunfish.	24,538	1,525	45,458	4,105	37,545	3,270	26,361	2,720	22,734	2,045
Swordfish.			3,980	267			100	15	500	100
Tautog or blackfish.	15,176	1,512	55,725	4,940	47,546	4,526	13,980	1,761	107,526	12,211
Thickfish.	82,153	6,336	264,517	21,830	217,199	135,621	115,609	13,995	96,182	6,228
Tomcod.			1,280	98	11,096	562		7,116		
Trout:										
Brook.	1,746	1,177	1,320	949	367	251	265	189	1,238	668
Lake.	22,025	3,306	34,168	4,661	40,697	4,625	1,447	229	2,241	30
Salmon.	6,065	617	8,449	1,217	13,575	2,087	1,728	283	3,521	787
Whitebait.	7,787	77	1,445	288	6,987	890			2,108	31
White bass.	7,397	911	11,719	1,124	2,074	261	285,490	8,417	2,066	386
Whitedisk.	43,534	9,418	156,905	20,561	199,204	32,980	389,913	5,417	5,275	872
Whiting.	744,505	23,958	1,403,546	53,111	1,994,718	80,375	289,913	11,989	165,177	6,267
Yellowtail or silver perch.	7,080	332	7,465	381					4,908	416
Miscellaneous.	85,092	4,268	50,444	4,182	17,384	1,698	28,625	3,134	18,139	1,495
Total.	11,444,457	1,202,284	13,471,111	1,389,080	13,216,941	1,211,476	9,083,080	1,082,275	6,362,932	906,933

Of the preceding, the following were landed by fishing vessels:

Species.	September.		October.		November.		December.		January.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Albacore or horse mackerel.....	868	\$55	176	\$12						
Bonito.....	52,332	15,860	143,515	36,356						
Bonito.....	8,795	1,099	1,923	337						
Butterfish.....	391	51								
Cod.....	54,309	3,826	139,718	13,422	107,507	\$9,417	28,437	\$2,660	2,704	\$353
Croaker.....			72	6	4,492	404	168	26	143	19
Eel.....			143	5					926	46
Eel, conger.....										
Flounders.....	7,283	905	7,088	876	8,732	200				
Grayfish.....					7,900	173	1,203	84		
Haddock.....	2,677	314	15,694	1,520	9,671	1,012	2,881	315	135	18
Hake.....	863	23	2,015	135	1,663	86	533	27	605	59
Herring, sea.....	7,017	300								
Mackerel.....	8,377	66								
Menhaden.....	8,263	103								
Pollock.....	29,498	3,137	2,215	286	3,457	277	373	32		
Scup or porpy.....	29,434	3,130	1,655	269						
Sea bass.....	1,953	234	3,013	630	5,598	1,053				
Shad.....	1,116	4	2,139	56	840	33	1,497	90	4,264	204
Spot.....	4,373	384								
Squid or weakfish.....	33,194	4,327								
Weakfish.....	82,133	6,365	266,917	21,227	214,924	19,911	127,062	13,001	105,874	12,021
Whiting.....	1,000	100			295	11				
Other fish.....	1,267	27			73	8				
Total.....	298,747	36,640	577,576	75,077	365,063	32,582	162,146	16,235	114,670	12,720

FISHERIES OF LAKE PEPIN AND LAKE KEOKUK.

A statistical canvass of the fisheries of Lakes Pepin and Keokuk for 1917 was made during the year, covering the same ground as in the canvass of these lakes for the year 1914. Lake Pepin is about 25 miles long, being an expansion of the Mississippi River between Minnesota and Wisconsin. Lake Keokuk, which was called Lake Cooper in the returns for 1914, but changed to Lake Keokuk by the United States Geographic Board, is formed by the dam across the Mississippi River at Keokuk, Iowa, the water backing up for a distance of about 50 miles.

Since the building of the dam, much speculation has been indulged in by the fishermen as to its effect on the fishing in the upper river. Considerable interest, therefore, attaches to the statistics of the fisheries in these lakes for the years mentioned, the first canvass having covered the first calendar year following the closing of the dam.

Lake Pepin.—In 1917 there were 181 persons engaged in the fisheries of this lake; the value of boats, fishing apparatus, and shore and accessory property employed was \$59,051; and the products taken amounted to 1,212,809 pounds of fish, having a value to the fishermen of \$78,555.

The most important forms of fishing apparatus used were fyke nets, seines, and anchored gill nets. Fyke nets, known locally as hoop nets, took 595,769 pounds of fish, or 49.1 per cent of the total catch, valued at \$46,333; seines, 459,504 pounds, or 37.8 per cent, valued at \$21,929; and anchored gill nets, 150,465 pounds, or 12.4 per cent, valued at \$9,991. The remainder of the catch, amounting to 7,071 pounds, valued at \$302, was taken with trap nets and trot lines.

The principal species taken were buffalofish, catfish, fresh-water drum, and Asiatic carp. These species constituted about 94 per cent of the total output. A number of other species, including bowfin, quillback or white carp, and suckers, were also taken in considerable quantities.

Compared with the returns for 1914, there was a slight decrease in the number of persons engaged, but an increase of \$15,452, or 35.4 per cent, in the amount of capital invested, and of 454,139 pounds, or 59.8 per cent, in the quantity, and \$44,836, or 132.9 per cent, in the value of the products. There was a large increase in the catch of bowfin or dogfish, buffalofish, catfish, Asiatic carp, and mooneye, but a decrease in fresh-water drum, quillback, spoonbill, lake sturgeon, and suckers.

Lake Keokuk.—The number of persons engaged in the fisheries of this lake in 1917 was 118, the value of boats, fishing apparatus, and shore and accessory property was \$21,879; and the products amounted to 1,800,986 pounds, valued at \$89,117.

Fyke nets were the most important fishing apparatus used, the catch amounting to 1,670,657 pounds of fish, or 92.7 per cent of the total output, valued at \$82,491. Trammel nets were next in importance, with a catch of 89,346 pounds, or 4.9 per cent of the total, valued at \$3,625. The remainder of the products were taken with seines, anchored gill nets, trap nets, and trot lines.

The leading species taken in this lake were buffalofish, catfish, fresh-water drum, and Asiatic carp, and constituted about 96 per

cent of the total catch. Blackbass, bowfin, crappie, eels, quillback or white carp, sunfish, and various other species were taken in smaller quantities.

Compared with 1914, there was an increase of 12.3 per cent in the number of persons engaged, 35.1 per cent in the investment, and 1,139,851 pounds, or 172.4 per cent, in the quantity, and \$65,817, or 282.4 per cent, in the value of the products. The catch of black bass increased from 15 pounds, valued at \$1, to 4,163 pounds, valued at \$418; crappie, from 70 pounds, valued at \$4, to 17,560 pounds, valued at \$1,108; and sunfish from 50 pounds, valued at \$3, to 13,879 pounds, valued at \$813. There was also a large increase in the catch of buffalo-fish, catfish, fresh-water drum, and Asiatic carp. A decrease occurred in the catch of eels, sand sturgeon, and suckers. The species reported in 1917 which were not shown in the returns for 1914 were bowfin or dogfish, pike, quillback or white carp, and spoonbill cat or paddlefish.

Statistics of the fisheries of these lakes in 1917, and also comparative statistics for the years 1914 and 1917, are given in detail in the following table:

FISHERIES OF LAKE PEPIN AND LAKE KEOKUK (MISSISSIPPI RIVER) IN 1917.

Items.	Lake Pepin.		Lake Keokuk.	
	Number.	Value.	Number.	Value.
Persons engaged:				
Fishermen.....	126		118	
Shoremen.....	5			
Total.....	131		118	
Boats, apparatus, and other property:				
Gasoline boats.....	35	\$6,810	32	\$4,730
Rowboats and barges.....	52	1,386	64	510
Houseboats.....	3	250	16	2,975
Fyke nets.....	263	37,472	1,968	5,330
Seines.....	17	6,400	1	800
Anchored gill nets.....	371	2,350	13	472
Trammel nets.....		450	17	221
Trap nets.....	14	13	81	123
Trot-lines.....		3,351		1,630
Shore and accessory property.....				
Total.....		50,051		21,570
Products by apparatus:				
With seines—				
Bowfin (dogfish).....pounds..	3,792	79		
Buffalofish.....do.....	60,073	3,457	578	64
Carp.....do.....	275,439	12,210	6,197	230
Catfish.....do.....	52,041	4,252	2,422	205
Crappie.....do.....			16	1
Fresh-water drum.....do.....	52,742	1,381	1,417	85
Mooneye, smoked.....do.....	650	195		
Pike.....do.....			4	1
Quillback or white carp.....do.....	9,245	120		
Spoonbill cat or paddlefish.....do.....	1,375	83	512	25
Sturgeon, lake.....do.....	40	9		
Suckers.....do.....	4,108	127		
Total.....	450,504	21,920	11,446	730
With fyke nets—				
Black bass.....pounds..			4,163	418
Bowfin (dogfish).....do.....	20,220	208	26,000	300
Buffalofish.....do.....	208,994	18,060	667,946	26,088
Carp.....do.....	100,422	6,411	678,140	25,252
Catfish.....do.....	175,535	17,534	97,486	7,084
Crappie.....do.....			17,544	1,108
Fresh-water drum.....do.....	59,830	1,925	158,058	7,901
Mooneye, fresh.....do.....	7,656	77		
Mooneye, smoked.....do.....	6,000	600		

FISHERIES OF LAKE PEPIN AND LAKE KOOKUK (MISSISSIPPI RIVER) IN 1917—
Continued.

Items.	Lake Pepin.		Lake Kookuk.	
	Number.	Value.	Number.	Value.
Products by apparatus—Continued.				
With fyke nets—Continued.				
Pike..... pounds			18	82
Quillback or white carp.....do	4,876	\$113	5,936	244
Spoonbill cat or paddlefish.....do	766	64	415	33
Sturgeon, sand.....do			365	38
Suckers.....do	11,152	345	700	
Sunfish.....do			13,379	813
Total.....	595,769	46,333	1,670,657	82,491
With anchored gill nets—				
Buffalofish..... pounds	31,742	2,605	5,625	441
Carp.....do	90,947	4,623	4,500	302
Catfish.....do	25,332	2,583	1,010	92
Fresh-water drum.....do	273	10	112	6
Quillback or white carp.....do	417	10		
Spoonbill cat or paddlefish.....do	782	68		
Sturgeon, lake.....do	472	95		
Total.....	150,465	9,991	11,247	861
With trammel nets—				
Buffalofish..... pounds			22,094	960
Carp.....do			67,253	2,675
Total.....			89,346	3,635
With trap nets—				
Catfish..... pounds	396	40	1,668	150
Fresh-water drum.....do	5,450	191		
Total.....	5,846	231	1,668	150
With trot-lines—				
Carp..... pounds	780	33	6,161	241
Catfish.....do	445	38	7,318	626
Eels.....do			2,087	318
Fresh-water drum.....do			967	48
Sturgeon, sand.....do			89	7
Total.....	1,225	71	16,622	1,240
Grand total.....	1,212,809	78,555	1,800,986	89,117
Products by species:				
Black bass..... pounds			4,163	418
Bowfin (dogfish).....do	24,021	342	26,000	390
Buffalofish.....do	300,808	25,009	698,543	40,563
Carp.....do	467,588	23,277	762,259	28,800
Catfish.....do	254,249	24,437	109,904	8,192
Crappie.....do			17,580	1,103
Eels.....do			2,087	318
Fresh-water drum.....do	118,304	3,508	460,554	8,130
Mooneye, fresh.....do	7,656	77		
Mooneye, smoked.....do	7,250	866		
Pike.....do			20	3
Quillback or white carp.....do	14,238	259	5,936	244
Spoonbill cat or paddlefish.....do	2,923	215	927	68
Sturgeon, lake.....do	512	104		
Sturgeon, sand.....do			454	37
Suckers.....do	15,200	472	700	33
Sunfish.....do			13,379	813
Total.....	1,212,809	78,555	1,800,986	89,117

COMPARATIVE STATISTICS OF THE FISHERIES OF LAKES PEPIN AND KEOKUK FOR THE YEARS 1914 AND 1917.

Items.	1914		1917	
	Number.	Value.	Number.	Value.
LAKE PEPIN.				
Persons engaged:				
Fishermen.....	135		126	
Shoresmen.....	2		5	
Total.....	137		131	
Boats, apparatus, and other property:				
Gasoline boats.....	28	\$7,625	35	\$8,510
Rowboats and barges.....	63	1,300	52	1,365
Houseboats.....	1	100	3	250
Fyke nets.....	295	24,985	262	37,472
Seines.....	14	3,340	17	6,469
Anchored gill nets.....	664	4,421	371	2,339
Trap nets.....	8	480	14	430
Trot and hand lines.....		3		12
Shore and accessory property.....		1,335		3,851
Total.....		43,599		89,061
Products:				
Bowfin (dogfish).....pounds.	1,534	16	24,021	242
Buffalofish.....do.	261,260	19,728	309,808	25,008
Carp.....do.	237,517	7,623	467,588	23,377
Catfish.....do.	26,830	1,745	254,329	24,537
Fresh-water drum.....do.	131,785	2,480	115,904	3,808
Mooneya, fresh.....do.	9,300	85	7,555	77
Mooneya, smoked.....do.	1,465	70	7,250	863
Pike.....do.	60	5		
Quillback or white carp.....do.	60,605	864	14,235	269
Spoonbill cat or paddlefish.....do.	8,877	457	2,623	215
Sturgeon, lake.....do.	1,067	129	512	104
Suckers.....do.	18,340	439	15,340	472
Sunfish.....do.	50	5		
Total.....	758,670	33,719	1,212,809	78,555
LAKE KEOKUK.				
Persons engaged: Fishermen.....	105		118	
Boats, apparatus, and other property:				
Gasoline boats.....	36	3,870	53	4,730
Rowboats.....	84	1,250	64	510
Houseboats.....	10	1,075	16	3,975
Fyke nets.....	1,378	5,693	1,368	5,239
Seines.....		5	1	300
Anchored gill nets.....			12	130
Trammel nets.....	14	304	17	472
Trap nets.....			81	231
Trot and hand lines.....		153		122
Shore and accessory property.....		3,845		1,630
Total.....		16,190		21,879
Products:				
Black bass.....pounds.	15	1	4,153	419
Bowfin (dogfish).....do.			26,000	360
Buffalofish.....do.	249,900	9,252	696,543	40,563
Carp.....do.	302,365	7,823	762,259	25,800
Catfish.....do.	71,535	4,355	109,904	5,132
Crappie.....do.	70	4	17,880	1,108
Eels.....do.	3,800	280	2,087	318
Fresh-water drum.....do.	26,880	527	160,554	5,130
Pike.....do.			20	3
Quillback or white carp.....do.			5,936	244
Spoonbill cat or paddlefish.....do.			927	68
Sturgeon, sand.....do.	1,900	121	454	37
Suckers.....do.	4,640	164	700	36
Sunfish.....do.	50	3	13,579	213
Total.....	661,135	23,300	1,800,996	89,117

* No barges were reported in 1914.

* No hand lines were reported for 1917.

* Reported as lake sturgeon in 1914.

ALASKA FISHERIES SERVICE.**EXTENT OF THE ALASKA FISHERIES.**

In 1917 the fisheries of Alaska attained their highest development up to that time. The number of persons employed was 29,491, an increase of 5,497 over 1916. The capital invested was \$54,937,549, an increase of \$15,367,937. The value of the products as first placed on the markets was \$51,466,980, an increase of \$25,310,421. This marked advance in value, amounting to 96 per cent, was due partly to a larger catch and pack of important species, but mostly to an extraordinary increase of the market prices of canned salmon, ranging from 56 per cent for red salmon, 64 per cent for cohoes, 76 per cent for humpbacks, and 84 per cent for chums to 94 per cent for kings. The salmon industry continues to overshadow all other branches, and in 1917 surpassed all previous records as regards the quantity of products taken and the market value thereof. The augmented production was due in part to increased fishing and canning operations and in part to extremely heavy runs of fish in certain regions. The additional canneries numbered 18, including 3 which, while in existence in 1917, were not then devoted to salmon. South-eastern Alaska had a very heavy run of humpbacks, which gave an increased pack of more than 1,000,000 cases. In central Alaska there was a decline in the catch of both red and humpback salmon, but the Karluk and Alitak sections showed even larger runs of red salmon than in the exceptionally good year of 1916. Western Alaska had the largest catch of red salmon ever made there, aggregating more than 24,000,000 fish, or 2,500,000 in excess of the best previous year, 1914. The total number of salmon taken in all Alaska in 1917 was slightly over 92,600,000, of which 44,875,000 were humpbacks and 38,497,000 were reds.

The 118 salmon canneries in operation packed 5,947,286 cases (of 48 one-pound cans), valued at \$46,304,090, an increase of more than 1,000,000 cases over 1916. The other products of the salmon industry—namely, fresh, frozen, mild-cured, pickled, dry-salted, and smoked fish—had a value of \$1,473,991.

Ranking next to the salmon industry came the halibut fishery, with a catch valued at \$1,120,226; the herring fishery, \$767,729; the cod fishery, \$744,976; and the whale fishery, \$654,852, all of which were of greater value in 1917 than in the previous year.

Detailed statistics of all branches of the Alaska fisheries have been gathered by the Bureau and have been published, with discussion, in the annual report of the Alaska service.

TAX ON SALMON CANNED IN ALASKA.

The act of June 26, 1906, for the protection and regulation of the fisheries of Alaska, provides that packers of canned salmon shall pay a license tax on their output at a rate per case depending on the species packed. Salmon in Alaska is packed in cases containing 48 1-pound cans, 48 half-pound cans, or 96 half-pound cans. The bulk of the salmon is packed in 1-pound cans, 48 to the case. The Bureau of Fisheries has always assumed that a case of salmon for

the purpose of the law in question meant a definite amount, namely, 48 pounds of salmon, and in assembling statistics of the fisheries of Alaska it has consistently considered a package containing 48 half-pound cans of salmon as a half case.

Recently the clerk of the district court in southeastern Alaska, acting in accordance with an opinion by the United States attorney at Juneau, insisted that salmon canneries pay a license tax upon their canned product at so much per case, without reference to the quantity of salmon involved. This action was manifestly arbitrary in that the amount of taxes to be collected would be based not upon the quantity of salmon packed but upon a condition brought about by the desires of salmon packers or the changing notions of the public as to the size of case which could be handled to the best advantage.

The situation was brought to the attention of the Bureau of Fisheries by the Association of Pacific Fisheries. Upon the request of the Bureau, the Solicitor for the Department of Commerce rendered an opinion in regard to the matter, which was to the effect that a case of salmon within the meaning of the fisheries act of June 26, 1906, was a definite amount, 48 pounds of salmon. The matter was then referred to the Attorney General of the United States with the request that if he concurred in the opinion of the Solicitor, instructions be issued to the United States attorney at Juneau to enforce the collection of license taxes on that basis. The Attorney General concurred with the opinion of the Solicitor for the Department of Commerce, and instructions were issued to collect the tax on canned salmon in accordance therewith.

INSPECTION OF PRIVATE SALMON HATCHERIES.

Representatives of the Bureau have made the usual inspections of private salmon hatcheries maintained by companies engaged in salmon canning. Three of these plants, located at Loring, Quadra, and Hetta, were operated in 1917-18. Their work was in general found to be conducted in a satisfactory manner, but additional facilities for rearing salmon should be provided in order that they may fulfill their highest purpose. The output of these hatcheries during the fiscal year 1918 was 23,712,000 red-salmon fry, all of which were planted in local waters. Under the law, the rebates of taxes on canned fish allowed as an offset to the hatching operations amounted to \$9,484.80.

WATERS CLOSED TO COMMERCIAL FISHING.

Pursuant to the authority conveyed by section 6 of the act approved June 26, 1906, and for the purpose of giving needed protection to salmon in various parts of Alaska, the following orders prohibiting or restricting salmon fishing were promulgated during the fiscal year 1918 after hearings held in accordance with law. The orders became effective on January 1, 1918.

Karluk River, under date of November 30, 1917.—That until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, excepting only the native Indians taking limited numbers of salmon for their own consumption and not for sale or barter, be and is hereby prohibited in waters of Alaska, as follows: In Karluk River and Lagoon, and all tributary waters.

Bering River, under date of November 30, 1917.—That until further notice all fishing for salmon or other fishing in the prosecution of which salmon are taken or injured, be and is hereby prohibited in waters of Alaska, as follows: Bering River and all tributary waters, including Bering Lake, above a line extending at right angles across Bering River from a point approximately eight hundred (800) feet northwesterly from the mouth of Gandil River, Alaska.

Copper River, under date of December 29, 1917.—That until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in the Copper River and its delta, and all tributary waters, Alaska, be, and is hereby, made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Commercial fishing is prohibited in all waters of the Copper River delta from 6 a. m. on January 1 to 6 a. m. on June 1 of each year, and in the waters of Miles Lake and Abercrombie Canyon from 6 a. m. on January 1 to 6 a. m. on June 5 of each year.

2. A weekly close season from 6 p. m. Saturday to 6 a. m. of the Monday following shall be observed in all of the waters herein referred to, in which fishing is permitted.

3. Commercial fishing in the waters of the delta shall be limited to set nets, stake nets, and drift gill nets: *Provided, however,* That the four existing traps east of Cape Whitshed may be continued in operation, but without change of location or increase in size. No stake net, set net, or drift gill net shall exceed 1,000 feet in length. Only one stake net or set net shall be extended out from shore from one location, and no offshore stake nets or set nets will be permitted; the lateral distance interval between all such nets in the waters of the delta shall be not less than 1,800 feet.

4. All fishing is prohibited from the head of the delta to the foot of Miles Lake at all times.

5. All fishing in Miles Lake shall be limited to stake nets and set nets. No such nets shall exceed 600 feet in length, and only one such net shall be extended out from shore from one location; no offshore nets will be permitted in the lake. The lateral distance interval between all nets in Miles Lake shall be not less than 600 feet.

6. Fishing in Abercrombie Canyon shall be restricted to the use of dip nets operated by hand, such nets not to exceed 16 inches in greatest diameter and only one dip net shall be operated by a person. On the east side of the canyon there shall be distance intervals of at least 300 feet between fishermen operating dip nets. No fishing will be permitted in the so-called bear holes near the upper end of Abercrombie Canyon.

7. No fishing will be permitted at any time in the waters of the Copper River above Abercrombie Canyon, or in any of the waters tributary thereto, except in the case of local residents, who may take limited numbers of salmon for domestic use: *Provided,* That such fishing shall at no time be upon the spawning grounds of any salmon.

8. No set net or stake net shall be operated in any other than substantially a straight line.

9. For the purposes herein considered, the delta of the Copper River will be regarded as including all waters south of an east and west line passing through Mile 27 on the Copper River & Northwestern Railway, as at present established, and inside of a line from Point Martin to Cape Whitshed drawn so as to include the waters of the Martin Islands, the Egg Islands, and all tidal flats and islands between.

10. The lower end of Miles Lake shall be considered as at the bridge of the Copper River & Northwestern Railway at Mile 49. The upper end of Miles Lake shall be considered as at a point near Mile 52½ on the Copper River & Northwestern Railway where the river loses its identity in the lake, this point to be as indicated by notices posted by duly authorized representatives of the Bureau of Fisheries.

11. Abercrombie Canyon shall be considered as extending from the upper end of Miles Lake to Tunnel Point, near Mile 53½ on the Copper River & Northwestern Railway.

12. For the purposes of this order the following definitions are adopted to apply to the words in question where the same are used: "Stake net," a gill net attached or affixed to piles or stakes; "set net," an anchored gill net.

FISHERY PATROL AND STREAM WATCHMEN.

During the fishing season of 1917 the Bureau employed in the fishery patrol of the Alaskan coast two small vessels, named the *Murre* and the *Auklet*, after local sea birds, which had been built to order and put in commission in July. These are seaworthy craft, constructed after the well-tried salmon purse-seine boat, and have given entire satisfaction. In addition to the *Osprey*, which was put into commission in the latter part of the fiscal year, the Bureau hired for the fishery patrol of the Prince William Sound, Cook Inlet, and Nushagak regions a schooner and three launches.

For the season of 1918 there was placed in service at Fairbanks a boat which the Bureau had built for the use of its employees in connection with field work on the Yukon River and its tributaries. This boat will greatly facilitate the work of the wardens and others in enforcing the laws for the protection of fisheries and also fur-bearing animals in the interior of Alaska. This boat, named the *Swan*, is 32 feet in length and is equipped with a 20-horsepower motor. There are sleeping accommodations for two persons. Heretofore employees of the Bureau have been dependent upon private boats for transportation in these waters.

For the fishing season of 1918 the Bureau inaugurated an additional feature for securing the more adequate enforcement of the fishery laws. A number of temporary employees, designated as stream watchmen, were detailed to important fishing grounds in southeastern and central Alaska. Each watchman was assigned a limited area to patrol, which he was expected to keep under continuous observation. In certain regions where fishing is carried on by means of gill nets, haul and purse seines, or other movable apparatus, these watchmen will be much more effective than patrol boats. Patrol boats can enforce the law in respect to movable apparatus only while actually present at the fishing grounds where it is used. The appropriation necessarily limited the number of men who could be advantageously employed in this way. However, by selecting certain strategic points for operations and by shifting the watchmen from one stream to another in response to changing conditions in respect to fishery operations it is thought that a very considerable amount of protection may be afforded the fisheries at comparatively small cost.

Ten men were employed to undertake this work. Seven of them were secured through the dean of the University of Washington, five of the seven being students at the university and two being professors, while an eighth was a graduate of the university. One man was secured in the State of Washington, and the tenth man was engaged in southeastern Alaska. Five of the men were assigned to work in southeastern Alaska and five in central Alaska under the immediate direction of the Bureau's regular officers. A number of small boats were hired for the use of these men.

Various prosecutions have been instituted in the Alaska courts and before United States commissioners for violations of laws and regulations for the protection of salmon. The violations consisted mostly of nonobservance of the weekly close season, operation of gear within prohibited distances of other gear, and failure to mark

pound nets so that ownership could be determined. In most cases a plea of guilty was entered and fines were imposed.

CENSUS OF RED SALMON IN WOOD RIVER.

The Bureau has continued to make the annual count of the red salmon passing up Wood River to their spawning grounds in Lake Aleknagik. The 1917 census, conducted as in previous years, and with the usual indispensable assistance of the Alaska Packers Association and the Alaska-Portland Packers' Association, showed an escapement from the active fishing in the Nushagak River of 1,081,508 red fish between June 26 and August 1. The heaviest runs occurred on July 11 to 14, inclusive, when 529,588 fish were counted.

The purpose of this census has been fully explained in previous reports. The results since its inception have been as follows:

	Number.		Number.
1908-----	2, 800, 655	1913-----	753, 109
1909-----	893, 244	1915-----	259, 341
1910-----	670, 104	1916-----	551, 959
1911-----	354, 299	1917-----	1, 081, 508
1912-----	325, 284		

FISHERY INTELLIGENCE SERVICE.

The Bureau has continued to carry out the wishes of the Legislature of Alaska, as set forth in a memorial asking that the Bureau of Fisheries, in conjunction with the Washington-Alaska Military Cable and Telegraph System, arrange to have the prices of fresh fish at Seattle and Ketchikan bulletined every day at the cable office of every town on the Alaska coast where fishing vessels call for the purpose of shipping fish southward and to have once a week the prices of salt fish of the varieties caught in Alaska waters bulletined at the cable offices of the Alaska coast. The War Department, which operates the Washington-Alaska Military Cable and Telegraph System, expressed its willingness to receive, transmit, and post bulletins furnished by the Bureau of Fisheries, and early in July, 1917, the service was initiated, the information thus furnished including (1) the forwarding each day, Sundays and holidays excepted, to Juneau, Petersburg, Ketchikan, Wrangell, Sitka, Valdez, Seward, Cordova, and Skagway the noon Seattle prices for fresh halibut, sablefish, and red rockfish; (2) inclusion with the Seattle quotations on Monday of each week the prices of pickled sablefish, salmon, and herring; and (3) the furnishing from Ketchikan of local information, corresponding to that furnished from Seattle, to the other Alaska towns supplied with the Seattle quotations. The purpose of this service is to keep the fishermen of this remote coast in touch with market conditions, so that they may dispose of their catches more profitably, and thereby be induced to increase the production of fish. The service has met with general favor.

FISHERY EXPLOITATION WORK.

The success which attended the Alaska work of the Bureau in the fishing season of 1917 in distributing literature and sending special assistants to the field to demonstrate practical operations, particularly

with respect to introducing the Scotch method of curing herring, encouraged it in renewing similar operations in the 1918 season. The results have proved the value of this undertaking, and there is every reason to believe that there will be a further gratifying increase in the production of herring and various more or less neglected fishes.

ESTABLISHMENT OF SALMON CANNERIES ON YUKON RIVER.

The proposed establishment in 1918 of a salmon cannery at Andreadfski on the Yukon River brought forth strong protest from many quarters. It was advanced that cannery operations on the Yukon would deplete the supply of salmon upon which the natives living along the river and its tributaries depended in a large degree for their subsistence. It was also claimed that the white population would suffer if this source of food should be restricted to the extent feared. The Yukon and its tributaries drain a large extent of inhabited territory, and while most rivers in Alaska are fished near their mouths only, the waters of the Yukon are the scene of fishery operations from Bering Sea to points in Canada many hundreds of miles from the sea.

On account of the protests which were made, a hearing was held at Seattle on May 17, 1918, at which persons interested in the matter were given an opportunity to be heard. At the hearing it did not develop that there was any particular alarm in regard to the depletion that would be caused by the operation of a single cannery. The apprehension was that this particular cannery would be but one of many to be built, the aggregate result of which would be the depletion of the Yukon salmon supply. The Bureau has made arrangements to hold another hearing in regard to the matter at Seattle on November 20, 1918. Meanwhile, steps have been taken for a survey of the salmon resources of the Yukon and its tributaries and determination of the extent to which salmon are utilized by natives and other residents of the region in question. A number of employees of the Bureau have been detailed to make a special study of the situation on the ground. All persons known to be interested in the matter have been supplied with schedules to be filled out by them and returned to the Bureau, which it is hoped will develop further information. The Bureau of Education is cooperating with the Bureau of Fisheries in the matter, and officials of the Department of Justice in Alaska are rendering assistance.

PERMITS FOR COMMERCIAL FISHERY OPERATIONS IN ALEUTIAN ISLANDS.

In the fiscal year 1918 permits authorizing certain fishery operations within the Aleutian Islands Reservation were issued as follows:

1. Alaska Commercial Co., authorized to engage in the business of preserving cod and salmon for commercial purposes, erection of any cannery excepted.

2. Umnak Livestock Co., authorized to engage in the business of preserving cod and salmon for commercial purposes, erection of any cannery excepted.

3. Paul Buckley, authorized to engage in the business of taking and utilizing whales for commercial purposes, erection of any cannery excepted.

4. N. E. Bolshanin, authorized to engage in the business of salting cod and salmon for commercial purposes, erection of any cannery excepted.

5. Kuskokwim Fishing & Transportation Co., authorized to establish a shore station for use in connection with the taking and preservation of cod and salmon for commercial purposes, erection of any cannery excepted.

6. Alaska Fishing Co., authorized to take not to exceed 1,000 barrels of salmon and to sell the same either fresh or salted.

7. Northern Fisheries (Inc.), authorized to engage in the business of preserving cod for commercial purposes, erection of any cannery excepted.

8. Alaska Commercial Co., authorized to purchase fish from natives resident of the reservation and to preserve and sell the same for commercial purposes.

9. O. K. Quean, authorized to pack and dispose of for commercial purposes not to exceed 20 tons of cod and 200 barrels of salmon.

10. Edwin H. Larsen, authorized to establish and operate a saltery for use in connection with the taking and preservation of cod and salmon for commercial purposes.

11. Northern Fisheries (Inc.), authorized to engage in the pickling of salmon, trout, atkafish, and other fishes for commercial purposes.

12. Buckley Livestock, Fisheries & Transportation Co., authorized to engage in cod-fishery operations upon Unalaska Island and to build thereon suitable bunk houses, cookhouses, and storage buildings necessary to carry on the business of catching, salting, and otherwise curing codfish.

13. Buckley Livestock, Fisheries & Transportation Co., authorized to construct and operate on Unalaska Island a plant for the canning or salting of salmon or other food fishes taken in the vicinity of Unalaska Island.

14. Unalaska Atkafish Co., authorized to engage in the salting or mild curing of atkafish, codfish, and salmon for commercial purposes.

15. A. C. Goss, authorized to engage in miscellaneous fishery operations, construction or operation of any cannery excepted.

16. Alaska Fishing Co., authorized to engage in commercial fishery operations at Unalaska Island, construction or operation of any cannery excepted.

ALASKA FUR-SEAL SERVICE.

GENERAL ADMINISTRATIVE MATTERS.

A very full report on the fur-seal service in all its branches during the season of 1917 is contained in the document entitled "Alaska Fisheries and Fur Industries in 1917." This may be consulted by persons desiring to know details of the affairs of the Pribilof Islands natives, fur seals, foxes, reindeer, and other matters.

The greatly increased cost of supplies of all kinds rendered inadequate the appropriation for the fur-seal branch of the general Alaska service for 1918 and necessitated an appeal to Congress for a deficiency appropriation of \$35,000, which became available in October, 1917.

In April, 1918, there were sent to the Pribilofs three motor trucks, two for St. Paul Island and one for St. George Island. Reports indicate that these trucks have already proved very useful in various ways; and with the gradual extension of road facilities, in which the trucks will be of great aid, their usefulness will undoubtedly increase.

It is gratifying to record that the natives of the Pribilof Islands responded in a patriotic way to the third call for Liberty Loan subscriptions. From funds held in the custody of the Commissioner of Fisheries for certain of these natives, seven on St. Paul and four on St. George requested that bonds aggregating \$1,150 be purchased for them. One woman subscribed for \$400. From funds due for taking fox skins, 24 natives subscribed for bonds aggregating \$1,200, each of the 24 subscribing for a \$50 bond.

The act providing for the sundry civil expenses of the Government for the fiscal year 1919 appropriated \$20,000 for the purchase or construction of a wooden power lighter for use at the Pribilof Islands. Arrangements have been made for the construction of a suitable vessel. The craft will be about 70 feet in length and 17 feet in breadth, with a cargo capacity of 30 to 40 tons, and provided with an internal-combustion engine of about 80 horsepower. Sleeping accommodations will be available for 6 employees of the Bureau and for 10 natives. The vessel will be substantial and seaworthy, and able to make trips when necessary from the Pribilof Islands to Unalaska, a distance of 250 miles across Bering Sea. It is planned that the vessel will be ready for service next season.

Early in 1918, in response to the request of the Department of Commerce, the Navy Department arranged for the detail of a Coast Guard vessel for patrolling the North Pacific Ocean and Bering Sea for the protection of fur seals and sea otters. A patrol for the purpose indicated is required by the provisions of the North Pacific Sealing Convention of July 7, 1911.

In order to obviate the waste of such valuable products as oil and fertilizer, obtainable from the carcasses of seals, the installation of a reduction plant has been a great desideratum at the Pribilof Islands. Money for this purpose having been made available by the President, the necessary machinery, equipment, and other materials have been purchased and forwarded to St. Paul Island, and the plant will shortly be ready for use.

The transportation of persons and supplies to the seal islands and of persons and products therefrom has been efficiently performed by the steamer *Roosevelt*, which during the fiscal year made three trips from Seattle and gave the islands a more adequate service than was ever before possible. While operating expenses of this vessel are considerable, they are far less than would be required for the unsatisfactory transportation such as was formerly rendered by chartered vessels. In fact, the work performed by the *Roosevelt* during the year would, if done by a private vessel, have cost the Government a sum that would cover the purchase price of this vessel.

With the publication of Funsten Bros. & Co.'s catalogue which announced the sale of sealskins at St. Louis on April 22, 1918, there were formally adopted new terms for use in classifying sealskins.

The terms formerly used represented the fortuitous outgrowth of years and were in some cases misleading in that they gave the uninitiated the impression that skins were taken from seals which are never killed for commercial purposes at the Pribilofs. The new terms avoid the faults of the old, and each one means that the skin to which it is applied has a length varying only within specified limits. It is believed that this innovation will meet with general approval by the fur-buying public. A comparison of the old and new terms, with the size limits of the new terms, follows:

Old classification.	New classification.	Lengths.
Wigs.....	Wigs.....	Inches. Above 55
Middlings.....	Extra extra large.....	49 to 55
Middlings and smalls.....		46 to 48
Smalls.....	Extra large.....	43 to 46
Large pups.....	Large.....	39 to 43
Middling pups.....	Mediums.....	35 to 38
Small pups.....	Small mediums.....	

RESUMPTION OF SEAL KILLINGS FOR COMMERCIAL PURPOSES.

By the provisions of the act of Congress approved August 24, 1912, giving effect to the North Pacific Sealing Convention of July 7, 1911, it became permissible to take fur-seal skins for commercial purposes at the Pribilof Islands after August 24, 1917. The season when seal-skins can be obtained for commercial purposes to best advantage ends about August 10, and for this reason no considerable number of skins were secured in 1917. Early in 1918 the Secretary of Commerce tentatively authorized the taking of 25,000 skins during 1918, this number to be increased later should the conditions warrant. The quota was apportioned between the two islands as follows: 20,000 to St. Paul Island and 5,000 to St. George Island. By July 31, 1918, the take of sealskins on St. Paul Island in the calendar year was 23,889 and on St. George Island 6,711. Following the unanimous opinion expressed by responsible Government representatives on the islands, the Secretary in July, 1918, authorized an increase in the season's quota from 25,000 to 35,000 skins, 28,000 being apportioned to St. Paul Island and 7,000 to St. George Island. To August 10, 1918, the skins taken numbered 33,881.

In connection with the expansion of sealing operations at the Pribilofs it was evident that outside assistance would be necessary on St. Paul Island if the desired number of skins was to be taken. Arrangements were accordingly made whereby Funsten Bros. & Co., of St. Louis, the firm which sells for the Department the sealskins taken at the Pribilofs, sent 5 men to assist with those features of the work which require more or less expert knowledge of the handling and care of furs. To supplement the services of the natives of St. Paul in the killing of seals, the taking of skins, etc., 11 natives were hired at Unalaska and taken to the islands early in the sealing season.

AUTHENTICATION OF FUR-SEAL SKINS TAKEN BY WASHINGTON INDIANS.

The Bureau has again had the cooperation of the superintendent of the United States Indian Service at Neah Bay, Wash., in the matter of authenticating fur-seal skins lawfully taken by Indians dwell-

ing on the coast of Washington. The North Pacific Sealing Convention of July 7, 1911, permits these Indians to take sealskins under certain restricted conditions.

To July 31, 1918, the skins thus authenticated numbered 395. The records submitted show that 388 of the seals involved were taken in April, May, and June, 1918. Information as to when the other 7 were captured is not stated but it is assumed that they were taken in the same months. The records also show that 251 of the seals were males, 142 females, the sex of 2 not being given. All of the seals were speared from canoes operating from 10 to 25 miles west of La Push, Wash.

While it is regretted that so large a proportion of female seals were captured, yet so long as the Indians are to have the privilege of taking seals it is not seen how the killing of females can be prevented. The Indians should undoubtedly continue to have the privilege which they now possess, and with the herd in its present condition the number of females taken can not materially affect its status.

CONDITION OF THE SEAL HERD.

The census of the Alaskan seal herd in 1917 gave a total of 468,692 seals of all ages. The census was again under the immediate charge of G. Dallas Hanna, of the Alaska service, who was assisted by Dr. Harold Heath and members of the islands staff. The 1918 census, although taken in the early part of the fiscal year 1919, should be noted in this report. It was made under the same circumstances as formerly, Mr. Hanna in charge and Dr. Heath assisting. The number of pups born was 143,005, representing an equal number of breeding cows, and the total strength of the herd as of date of August 10 was computed to be 496,611, exclusive of 33,881 seals killed for commercial purposes during the year. The only variation from former methods of calculation was to increase from $12\frac{1}{2}$ to 20 per cent the annual natural mortality among the bulls, a course which appeared to be justified by information gained during this census.

The great preponderance of old male seals, resulting from the enforced suspension of commercial sealing for five years, is the only unsatisfactory feature of the herd. The breeding males on the islands in 1918 were sufficient for a herd of 740,000 cows, allowing 30 cows to a harem.

SALES OF PRIBILOF ISLANDS PRODUCTS.

During the fiscal year 1918 the revenue derived from the sale of products of the Pribilof Islands was \$417,815.20 gross and \$296,228.85 net, the difference being largely in the cost of dressing and dyeing sealskins before their sale at public auction. There were two sales of sealskins, in October, 1917, and April, 1918, the number disposed of being 9,339 and the gross receipts \$379,392. Fox skins, taken during the winter of 1916-17, were sold in October, 1917, 567 being blue and 39 white; the gross receipts therefrom were \$35,680.50. Two lots of old seal bones, aggregating 193,570 pounds, brought \$2,742.70 gross.

MINOR FUR-BEARING ANIMALS OF ALASKA.

ENFORCEMENT OF LAWS AND REGULATIONS.

The wardens and other employees of the Bureau have enforced the laws and regulations for the protection of the minor fur-bearing animals throughout Alaska. This duty has been performed as efficiently as the number of the agents permitted. Through the cooperation of the governor of Alaska the Bureau will be enabled to increase its personnel for the protection of fur-bearing animals in Alaska by the employment of game wardens in the Territory as special fur wardens. In return the Bureau has authorized the governor to appoint a number of its wardens as ex-officio game wardens.

FURS SHIPPED FROM ALASKA.

It is indicated by statistics compiled by the Bureau that during the period from November 16, 1916, to November 15, 1917, the value of the furs shipped from Alaska was \$1,028,719, exclusive of the fur seal and fox skins of the Pribilof Islands, as against \$911,244 in the preceding similar period. In a number of instances there was a decrease in the number of pelts shipped, but the average price of practically all furs showed a material advance, hence the aggregate value of the shipments in 1917 was considerably greater than that of the previous year.

Acknowledgment is made of the cooperation of the Post Office Department in securing accurate statistics of shipments of furs by mail. The arrangements in effect for several years were reaffirmed when under date of May 4, 1917, the Postmaster General issued an order slightly modifying the previous arrangement. It is now the duty of each postmaster in Alaska to furnish report blanks prepared by the Bureau of Fisheries to persons who present furs for mailing, and to see that no furs are sent to outside points until after the shipper has filled out the blank. The postmaster signs the blank and dispatches the shipment of furs without examining the contents. The report is forwarded to the Bureau of Fisheries.

NEW REGULATIONS FOR PROTECTION OF FUR-BEARING ANIMALS.

The only change made in the fiscal year 1918 in the regulations for the protection of fur-bearing animals in Alaska was one approved by the Secretary of Commerce under date of March 4, 1918, extending the close season on beaver until November 1, 1923. This change was made at the request of the Bureau, and was based in large part on the recommendations of wardens in its service and at the solicitation of the governor of Alaska and other persons having the welfare of the Territory at heart.

Beavers in Alaska have been afforded entire protection for a number of years and the resulting increase in their numbers has fully justified the action of the Department in the past. It was felt, however, that the reestablishment of the beaver in Alaska had been local rather than general, and that since the colonial habits of the beaver make extermination a comparatively easy matter, there should be complete protection for a further period of five years.

FUR FARMING IN ALASKA.

As for a number of years past, there has been some activity in fur farming. This has consisted chiefly of the liberation of adult foxes on islands, although in a number of instances corrals have been constructed and the work has been conducted along scientific and businesslike lines. Reports have been received indicating that there were 8 fur farms in operation in the interior of Alaska and that 20 islands were occupied for the breeding of fur-bearing animals. At the end of the fiscal year 1918 five islands under the jurisdiction of the Department had been leased for the propagation of fur-bearing animals; these were Middleton, Simeonof, Little Koniugi, Marmot, and Pearl Islands. The lease of Marmot Island was forfeited in 1918.

MISCELLANEOUS MATTERS.

SPECIAL CONSTRUCTIONS AND IMPROVEMENTS.

In January, 1918, the Rhode Island Legislature granted the United States permission to purchase the property which the Bureau has desired to acquire on Block Island for a marine fish hatchery. The land has since been purchased, title thereto has been perfected, plans for the station have been made, and construction will be begun if the greatly increased cost of material and labor will permit the completion of the hatchery and pumping plant within the appropriation.

No bid within the limit of the appropriation could be obtained for the new motor boat authorized for the Woods Hole (Mass.) station. The construction of two steel fish-distribution cars has not been possible, owing to the inability of properly equipped establishments to handle this kind of work at this time. Another piece of construction work that has lapsed is the lobster-rearing plant for which Congress made a small appropriation in 1917. The reduction of the size of this proposed plant to a point that greatly impairs its value still leaves its estimated cost far in excess of the appropriation. The project will have to be held in abeyance or Congress must increase the appropriation.

With the additional appropriation for the laboratory at Key West, Fla., there have been constructed a director's residence and a pump house, both of terra cotta hollow tile, and a concrete cistern for fresh water with a capacity of 2,000 gallons.

At the Cape Vincent (N. Y.) station, new machinery has been installed, and the purchase of about 7.5 acres of additional land is contemplated in order to construct ponds and institute pond culture at this point.

A double frame building for quarters has been built at the Boze-man (Mont.) station. Each part is 30 by 50 feet and contains 6 rooms.

At the Orangeburg (S. C.) station 5 new ponds have been constructed, and at the Saratoga (Wyo.) station 2 new ponds have been completed, and there have been extensive improvements to the water supply, including the addition of a filtering system.

VESSEL SERVICE.

The repairs which the steamer *Albatross* was undergoing at the Mare Island Navy Yard at the beginning of the year were completed

early in November, and on the 19th of that month the vessel was formally taken over by the Navy for the period of the war.

The steamer *Fish Hawk* was used by the Navy under an informal agreement from July 1 until January 11, when the vessel was sent to the yard of the Old Dominion Marine Railway Corporation at Berkley, Va., for repairs to hull and machinery, for which a special appropriation was provided. The principal items of work on the hull embrace a complete overhauling throughout, rebolting of sheathing, replacing worn plates, rearranging and modernizing space and quarters, a new keel, and a new main deck. There were installed a new condenser and fore-and-aft compound engines, designed to develop 200 horsepower. Although the repairs were not completed until August, 1918, the vessel was taken over by the Navy on July 18.

Two of the smaller steamers of the Bureau, the *Halcyon* and the *Phalarope*, have also been at the disposal of the Navy Department during the entire year.

Three of the older vessels, the *Grampus*, the *Curllew*, and the *Blue Wing*, having outlived their usefulness, have been condemned and sold.

While the *Roosevelt* was discharging cargo of supplies at the seal islands in May, 1918, an epidemic which had broken out among the crew was diagnosed as diphtheria. After the administration of anti-toxin by the physician at St. Paul Island, the *Roosevelt* proceeded to Unalaska to enter quarantine. While there a situation developed which led to the *Roosevelt's* making a most noteworthy series of rescues of lives and vessels. A number of cannery vessels had become caught in the ice in Bering Sea, and a great loss of life and property was imminent. Request was made for the assistance of the Coast Guard cutter *Unalga* and of the *Roosevelt*. The *Roosevelt* started out on the rescue work as soon as possible, and by reason of its construction the master was able to take it through the heavy pack ice and to meet the emergency in a way which probably could not have been done with any other vessel afloat. In the course of the operations the *Roosevelt* rescued the *St. Nicholas*, the *Centennial*, and the *Star of Chile*. Twenty-one persons from the wrecked vessel *Tacoma* were also rescued from a water-logged iceberg. It was estimated that at the time of rendering assistance to the *St. Nicholas* that vessel could not have survived more than 12 hours; more than 300 persons were aboard. The *Centennial*, with 161 persons aboard, might have survived another week at the time of its rescue.

FISHERY MATTERS IN CONGRESS.

No legislation affecting the Bureau aside from appropriation bills was passed by Congress during the fiscal year 1918, but a number of important measures in which the Bureau is concerned or interested were introduced and considered by the appropriate committees, including (1) a bill authorizing the construction of a building for the Bureau of Fisheries in the District of Columbia, (2) a bill to protect and conserve the halibut fisheries of the Pacific Ocean, (3) a bill to prohibit traffic in lobsters taken outside the territorial waters of Canada by United States vessels during the close season for lobsters in such waters, and (4) bills transferring the control of the fisheries of Alaska to the Territorial Legislature.

A bill to ratify the agreement or compact between the States of Washington and Oregon regarding concurrent jurisdiction over the Columbia River in connection with the fisheries passed the House of Representatives in March, the Senate in April, and became a law on April 8, 1918. The passage of this bill was advocated by the Bureau because of the stability it gives to laws for the protection of the salmon in the Columbia River.

AMERICAN-CANADIAN FISHERIES CONFERENCE.

The Commissioner was associated with the Secretary and the Assistant Secretary of Commerce as a member of the American-Canadian Fisheries Conference, appointed to consider outstanding-fishery questions between the United States and Canada. Following meetings in Washington, D. C., in January, 1918, the conference held public hearings in Boston and Gloucester, Mass., St. John, New Brunswick, Seattle, Wash., Ketchikan, Alaska, and Vancouver and New Westminster, British Columbia. At a meeting of the conference in Ottawa in May, adjournment was taken until September, in order that the testimony and exhibits might be fully considered before the preparation of a final report with findings and recommendations. The subjects that came before the conference were:

1. Privileges to the fishing vessels of either country in the ports of the other.
2. Rehabilitation and protection of the sockeye salmon of the Fraser River system.
3. Protection of the Pacific halibut fishery.
4. Fishing by United States lobster well-smacks off Canadian coast.
5. Protection of the fisheries of Lake Champlain.
6. Requirements imposed on Canadian fishing vessels passing through territorial waters of Alaska.
7. Protection of the sturgeon fisheries.
8. International protection of whales.

As an emergency war measure, in order that no restrictions may be placed on the production of food, the two Governments have reached an agreement under which the fishing vessels of either country are accorded in the ports of the other all the privileges enjoyed by domestic vessels. A bill has been drawn and introduced in Congress having for its object the suppression of the United States traffic in lobsters caught off the Canadian coast when there is a close time for lobsters on that coast. The Canadian Government has taken the necessary action to give to the fish in the Canadian waters of Lake Champlain the same protection that is accorded in New York and Vermont. The former discriminatory practice of requiring Canadian fishing vessels passing through the territorial waters of Alaska to enter and clear has been discontinued. The other subjects before listed as coming before the conference will require legislation or a treaty, or both.

Respectfully submitted.

H. M. SMITH,
Commissioner of Fisheries.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
COMMISSIONER OF LIGHTHOUSES

97796°—COM 1918—36

561

REPORT OF THE COMMISSIONER OF LIGHTHOUSES.

DEPARTMENT OF COMMERCE,
BUREAU OF LIGHTHOUSES,
Washington, September 15, 1918.

SIR: The following report is submitted of the operations of the Lighthouse Service for the fiscal year ended June 30, 1918:

The past year has been an unusually eventful and active one in the history of the Lighthouse Service. Under the Executive order issued shortly after the entering of the United States into the war nearly all of the lighthouse tenders, and a number of other units, with a total of 1,132 persons, have been serving with the Navy Department and at the same time continuing the work of maintaining the aids to navigation. The general lighthouse act passed in June, 1918, provides a retirement system for the field force of the Lighthouse Service and more adequate compensation for the light keepers and district officers. The important new lighthouse on Navassa Island in the West Indies was completed in October, 1917.

COOPERATION.

In accordance with the established custom of the Service, effort has been continued to consult the needs of maritime interests and to cooperate effectively with other branches of the Government in related work. The most important work of cooperation has been that with the Navy and War Departments in accordance with law and Executive order. The naval appropriation act of August 29, 1916, authorized the President, whenever in his judgment a sufficient national emergency exists, to transfer to the service and jurisdiction of the Navy Department, or of the War Department, such vessels, equipment, stations, and personnel of the Lighthouse Service as he may deem to be the best interest of the country; and also provided that the Secretary of the Navy, the Secretary of War, and the Secretary of Commerce shall jointly prescribe regulations governing the duties to be performed, etc. These regulations were issued April 11, 1917. By Executive orders, 46 lighthouse tenders, 4 light vessels, and 21 light stations have been transferred to the Navy Department, including a total of 1,132 persons employed thereon. These vessels and stations have since that time performed various duties under the Navy and have also continued the maintenance of the aids to navigation and other work necessary for the Lighthouse Service.

In addition to the officers and employees directly transferred, the superintendents of lighthouses and various other officers of the several lighthouse districts (46 persons) have reported to the Navy and Army authorities, and have rendered service in coordinating the military and lighthouse duties of the transferred portions of the Lighthouse Service.

The duties performed by the transferred units directly for the military and naval authorities are, of course, matters pertaining to those departments, but they consist principally of work on submarine nets and buoyage in connection therewith, patrol and watch service, drill in mine laying, etc. Prior to the war, for a number of years, a large proportion of the lighthouse tenders had been equipped by the War Department with mine-laying equipment, and had periodic drills in this work.

The regular work of the Lighthouse Service, the maintenance of lighthouses, lightships, buoys, and beacons, is of extreme importance in war time, to safeguard and expedite the movement of both merchant ships and naval vessels. This work has been increased rather than diminished by war-time demands and difficulties. The Lighthouse Service had prior to the war no surplus of vessels, equipment or personnel, beyond that necessary for the efficient maintenance of the existing establishment. The regulations under the law and Executive order providing for cooperation with the War and Navy Departments therefore contemplated the continuance of lighthouse work by the transferred units, and this has been done. By strenuous work on the part of the whole Service, and particularly the district and vessel officers, the great system of aids to navigation is being kept up in addition to the extra duties assigned to vessels and men.

In addition to the work done by the tenders and other units transferred, directly under the orders of military and naval officers, the Lighthouse Service cooperates in many other ways.

There has also been cooperation with the Navy and Treasury Departments in the improvement of coast communication facilities.

The following additional work has been performed: Various investigations have been made at the request of the Department of Justice and the military and naval information services. Officers of the marine engineering division of the Lighthouse Service have assisted the Shipping Board in various matters respecting the design and sea trials of various types of vessels, including concrete vessels. An officer of the Lighthouse Service is engaged on the work of the chain section, War Industries Board, having to do with the standardization and allocation of iron and steel chain for the different activities of the Government. The Commissioner of Lighthouses is serving as the representative of the Department of Commerce on the New York Harbor Wage Adjustment Board. A scientific assistant in the Lighthouse Service has assisted a naval technical board.

The Lighthouse Service endeavors to cooperate in every possible way with all other branches of the Government.

During the fiscal year 1918 services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 158 occasions. Particulars as to a few of the instances of assistance and cooperation by tenders and personnel of the Service are briefly mentioned as follows:

The tender *Tulip*, on February 7, 1918, during severe ice conditions, rendered assistance to the quartermaster's steamer *Pickering*, which was in distress at the entrance of New London Harbor, by reason of a damaged rudder, and towed that vessel to New London.

On February 20, 1918, the tender *Tulip* assisted a Navy transport by picking up a mooring which had been slipped and buoyed by the transport.

The tender *Anemone* rendered service on January 4, 1918, during severe ice conditions, to the steamer *Priscilla* of the New England Steamship Co., which was held up in the ice in lower Newport Harbor, by enabling the latter to reach her dock.

The tender *Oleander* rendered valuable assistance during February to vessels in distress as a result of the unusual ice conditions on the Ohio and Mississippi Rivers. Among the vessels assisted were several United States Engineer Department barges loaded with knock-down railroad cars for France, valued at \$100,000 each.

On February 3, 1918, the tender *Zizania*, while in the vicinity of Rockland, Me., was requested to proceed to Vinalhaven with mail, passengers, and provisions, the town having been shut off from all sources of supplies for upward of 11 days on account of severe ice conditions. Forty-three sacks of mail, 3 tons of freight, and 20 passengers were transported, and mail, freight, and passengers were transported from Vinalhaven to Rockland. On the return trip to Rockland the tender towed a disabled lobster boat to Rockland and then proceeded to the assistance of a schooner which was jammed in the ice in the bay and moving seaward.

On request of a Liberty loan committee the superintendent of lighthouses at Tompkinsville delivered and set up in the City Hall Park, New York City, a bell for furthering the campaign in behalf of a Liberty loan.

The Shipping Board recruiting service, Johns Hopkins University, was given assistance by an assistant superintendent in the Lighthouse Service, who conducted classes in steam engineering at the university by authority of the Bureau.

Arrangements were made for having the tender *Cedar* transport machinery to the Pribilof Islands, for the Bureau of Fisheries.

Acknowledgment has been received from various shipmasters and maritime interests of valuable assistance rendered by lighthouse tenders during the year, especially during the severe ice conditions of the winter, in aiding vessels in distress and keeping channels open for navigation.

Acknowledgment was received for cooperation during the past summer of the superintendent of the seventh lighthouse district with the wire-drag work of the Coast and Geodetic Survey.

Lake steamship interests have expressed their appreciation for efficient service rendered by the Lighthouse Service during the year in maintaining aids to navigation on the Great Lakes.

LIGHTHOUSE ON NAVASSA ISLAND.

The new light station on Navassa Island, West Indies, was placed in commission October 21, 1917. This was built under an appropriation of \$125,000 approved October 22, 1913, and was rendered necessary because of the increased traffic through the Windward Passage following the opening of the Panama Canal. Navassa Island lies in the passage between Haiti and Jamaica, and the light station is located on the highest part of the island. The tower is of reinforced concrete. The light is 395 feet above the sea, has 47,000 candlepower, and is visible 27 miles. The light has proved an important aid to vessels going through the Panama Canal to and from Atlantic ports of the United States. A detailed description of this station is given on page 633.

LEGISLATION ENACTED AFFECTING THE LIGHTHOUSE SERVICE.

The general lighthouse act approved June 20, 1918, contains provisions of much importance to the Lighthouse Service, including a retirement system for the field force, need for which has been pointed out from the first annual report of the Commissioner of Lighthouses in 1911, and emphasized in each succeeding report. Other important features of this act include more equitable compensation for the officers in charge of lighthouse districts, whose designation is changed from "lighthouse inspector" to "superintendent of lighthouses"; for the raising of the pay of keepers of lighthouses and an increased ration allowance for them. Provision for the payment of travel and subsistence expenses of teachers instructing the children of lighthouse keepers, and arrangements for the sale of publications of the Lighthouse Service are also included in this act and authorizations for a number of valuable special works of construction. The establishment and maintenance in the discretion of the Commissioner of Lighthouses of post lantern lights and other aids to navigation on Lakes Union and Washington, in the State of Washington, was also authorized by this act.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1919 are \$6,150,430 being \$811,750 in excess of those for the preceding fiscal year. In addition there are special appropriations aggregating \$723,000 for various new works.

The following works were authorized by the act of June 20, 1918, at the limits of cost specified, but no appropriation of funds was made: Constructing or purchasing and equipping lighthouse tenders and light vessels to replace vessels worn out in service in the third, fifth, and eighth lighthouse districts, or for use in the Lighthouse Service generally, \$760,000; enlarging and improving the lighthouse depot at Portsmouth, Va., in the fifth lighthouse district, or establishing a new depot, \$275,000; improving, repairing, establishing, and moving aids to navigation in St. Marys River, Mich., and vicinity, \$80,000; extending and enlarging the machine shop at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., \$30,000; establishing and improving aids to navigation in the Virgin Islands, of the United States and adjacent waters, West Indies, \$50,000; improving and extending the wharves at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., \$65,000; improving the aids to navigation and installing new aids in the Potomac River, Md. and Va., \$95,000; constructing and equipping a lighthouse depot for the eighth lighthouse district at New Orleans, La., or vicinity, \$88,500; and purchase of additional gas buoys for the improvement of aids to navigation in the fifth lighthouse district, \$125,000 (of which \$65,000 was appropriated by the sundry civil act of July, 1918).

The deficiency act approved October 6, 1917, made an appropriation of \$20,000 for repairing damage by hurricane at Aransas Pass Light Station, Tex.

The deficiency act of March 28, 1918, appropriated \$100,000 for repairing general hurricane damage to aids to navigation on the Gulf Coast; \$150,000 for repairing ice and storm damage to aids to navigation on the Atlantic coast; \$60,000 for repairs to wharves at the general lighthouse depot, Tompkinsville, N. Y., and \$15,000 for the

installation of an electrically operated fog-signal whistle at Nantucket Harbor, Mass.

The sundry civil act approved July 1, 1918, made the following appropriations: Depot for second lighthouse district, \$85,000; depot for sixteenth lighthouse district, \$90,000; improvements of depot at Detroit, Mich., \$53,000; Guantanamo Bay, Cuba, aids to navigation, dwelling for keepers, and improvements, \$14,000; Sand Island Light Station, Ala., improvements, \$37,000; Spectacle Reef Light Station, Mich., improvements, \$28,000; Ambrose Channel, N. Y., improving system of lighted buoys, \$26,000; fifth lighthouse district, purchase of additional gas buoys for improving aids to navigation, \$65,000; Joe Flogger Shoal, Delaware River, aids to navigation, unexpended balance of appropriation of \$40,000 for light and fog-signal station, made by act of June 30, 1906, is made available for establishing gas buoys and improving aids to navigation in the vicinity of Joe Flogger Shoal, Del.; the appropriation of \$15,000 for installation of fog-signal whistle on east breakwater, Nantucket Harbor, Mass., contained in deficiency appropriation act of March 28, 1918, is made available for a fog-signal ball at the same point. With the exception of the depot for the sixteenth lighthouse district, these projects were authorized by the acts of August 28, 1916, and June 20, 1918.

The sundry civil act of July 1, 1918, contained authority for the restoration of lighthouse structures with funds from the appropriation, "General expenses, Lighthouse Service;" and also for commuting the subsistence of working parties in the field, in connection with the appropriation, "General expenses," and making payment of the money accruing from such commutation to the persons having charge of the messes for the working parties.

The legislative act of July 3, 1918, provided for increased compensation during the fiscal year 1918 at the rate of \$120 per annum to all civilian employees of the Government, with certain exceptions, whose compensation does not exceed \$2,500 per annum, in lieu of the 5 and 10 per cent increase in force during the preceding fiscal year, but as a provision of the law excluded employees whose duties require only a portion of their time, a considerable number of lighthouse employees were affected and suffered what amounted to a virtual reduction in pay at a very inopportune time.

The act of July 1, 1918, making appropriations for the naval service for the fiscal year 1919, transferred to the Navy Department the unused Mare Island Light Station, Cal. This station was discontinued July 1, 1917, and is not further required for lighthouse purposes.

AIDS TO NAVIGATION.

During the fiscal year ended June 30, 1918, there was a net increase of 446 in the total number of aids to navigation maintained by the Lighthouse Service. There was an increase of 27 lighted buoys (including 14 float lights), 52 unlighted buoys, and 76 minor lights.

Fixed lights were changed to flashing or occulting at 13 stations. The illuminant of 3 lights was changed to incandescent oil vapor, the illuminant of 27 lights (including 2 light vessels and 10 buoys) was changed to acetylene, the illuminant of 14 lights was changed to electric incandescent.

On June 30, 1918, there were maintained by the Lighthouse Service 15,673 aids to navigation, including 5,545 lights of all classes and

587 fog signals (not including 81 whistle and 243 bell buoys), of which 51 are submarine signals.

The table following gives a summary of the aids to navigation, under each class, established and discontinued during the fiscal year, and also the net increase, and the number in commission at the end of the fiscal years 1917 and 1918.

Class.	1918			Total, June 30—	
	Estab- lished.	Discon- tinued.	In- crease.	1917*	1918
Lighted aids:					
Lights (other than minor lights).....	47	24	23	1,708	1,731
Minor lights.....	146	70	76	2,970	3,046
Light-vessel stations.....		1	b 1	53	52
Gas buoys.....	40	27	13	545	558
Float lights.....	28	14	14	144	158
Total.....	261	136	125	5,420	5,545
Unlighted aids:					
Fog signals.....		1	b 1	537	536
Submarine signals.....				51	51
Whistling buoys, unlighted.....	1	1		81	81
Bell buoys, unlighted.....	7	5	2	241	243
Other buoys.....	187	137	50	6,846	6,896
Day beacons.....	301	31	270	2,051	2,321
Total.....	496	175	321	9,807	10,128
Grand total.....	757	311	446	15,227	15,673

* Differences from statistics published in 1917 report are due to minor discrepancies in previous count.

b Decrease.

Improvements in aids to navigation in the Service generally have been made during the year as follows: Flashing or occulting lights were installed in place of fixed lights at 13 stations; incandescent oil-vapor lights were substituted for oil-wick lamps at 3 stations; acetylene or electric incandescent lights were substituted for other lights at 41 stations, including 2 light vessels and 10 buoys.

As previously mentioned, a new light station was established at Navassa Island, West Indies. A detailed description is given on page 633.

A number of important items of construction work were in progress at the close of the year, including a new light and fog signal at Chicago Outer Harbor, Ill., Chester and Marcus Hook Ranges, Delaware River, and a light and fog signal at Conneaut, Ohio.

It is believed that the systematic methods of improvement and the use of modern apparatus in increasing the number and brilliancy of aids have been of value to the safety of commerce.

Subsequent to the close of the fiscal year, on August 6, 1918, light vessel No. 71 was sunk on her station on Diamond Shoals by an enemy submarine. The crew took to their boats and reached shore without injury.

A severe hurricane visited the Gulf coast on September 27-29, 1917, damaging lighthouse property severely from the Mississippi River Passes east to Pensacola Bay.

During the months of January and February, 1918, the unusually cold weather—the most severe of record since 1856—occasioned a large amount of ice damage on the Atlantic coast as far south as the Cape Fear River, N. C. Cross Rip Light Vessel No. 6, Mass., was lost, having been torn from her moorings by a large field of floating

ice and carried seaward, where she disappeared, with six men on board. Every available means was taken by the Lighthouse Service for rendering assistance and making search for the light vessel, but without success. Another light vessel marking the lower entrance to Chesapeake Bay, Va., was dragged from her station by the ice, but was rescued by the lighthouse tender *Cypress*.

Many light stations and other aids to navigation were damaged or destroyed, including upward of 150 aids in the waters adjacent Maryland, Virginia, and North Carolina. The estimated damage amounted to nearly \$400,000, and a considerably larger amount than this will be required to reestablish the stations and provide against similar damage to these stations in the future. Important stations either wholly or practically destroyed were Choptank River, Md.; Bowlers Rock, Va.; Old Plantation Flats, Va.; North River, N. C.; and Wade Point, N. C. The following important stations were seriously damaged, or weakened so as to require strengthening: York Spit, Va.; Windmill Point, N. C.; Tangier Sound, Va.; Cobb Point Bar, Md.; Ragged Point, Md.; Thomas Point Shoal, Md.; Long Shoal, N. C.; Hatteras Inlet, N. C.; Brant Island Shoal, N. C.; and Neuse River, N. C.

An appropriation of \$150,000 was made by deficiency act of March 28, 1918, for repairs rendered necessary by this ice damage. Estimate for further appropriations for this object has been submitted, including riprap protection against future ice damage wherever the expense involved by such protection is considered justified as compared with the cost of rebuilding the aids.

ALASKA.

Special attention has been given to Alaska. Eleven new lights were established; 3 lights were changed from fixed to flashing; 1 gas and bell buoy was established, also 13 unlighted buoys, and 5 beacons. It is expected that 16 other lights will be established during this season, as well as 2 gas and bell buoys. Special appropriations aggregating \$290,000 will be asked of Congress to continue the work, of general increase of lights and buoys in Alaska, for a light and fog signal at Cape Spencer, Cross Sound, and for repairs and improvements at existing light stations.

The total number of aids to navigation in Alaska, including lights, gas buoys, fog signals, buoys, and daymarks, in commission at the close of the fiscal year ended June 30, 1918, was 439, including 161 lights and 7 gas buoys, representing an increase of 131 lighted aids since June 30, 1910, or 354 per cent. The following table, which gives the total number of aids to navigation on June 30 of 1910, 1915, and of each succeeding year, illustrates the progress in establishing aids in the Territory:

Aids.	1910	1915	1916	1917	1918
Lights.....	37	112	147	152	161
Gas buoys.....				7	7
Fog signals.....	9	10	11	11	11
Submarine bell.....				1	1
Buoys.....	84	167	181	189	199
Daymarks.....	30	49	49	56	61
Total.....	160	338	388	416	439

The acts of August 1, 1914 and June 12, 1917, each appropriated \$60,000 for establishing and improving aids to navigation in Alaskan waters. During the fiscal year 1918, one gas buoy, one oil post lantern, and six acetylene lights were established with funds from these appropriations; and the illuminating apparatus and other material for eight additional acetylene lights and three gas buoys purchased, of which several were nearing completion at the close of the fiscal year.

Special appropriations aggregating \$290,000 will be asked of Congress to continue the work of general increase of lights and buoys in Alaska, including a light and fog signal at Cape Spencer, Cross Sound, and other new aids, and improvements at existing stations. The sundry civil act of July 1, 1918, contained an appropriation of \$90,000 for a lighthouse depot with necessary equipment for this district.

The new lighthouse tender *Cedar* has been in commission throughout the year, attending to lighthouse work in Alaska, and has proven satisfactory for this purpose.

GUANTANAMO, SAMOA, AND GUAM.

The aids to navigation in the outlying United States territory at Guantanamo Bay, Cuba, the American Samoan Islands, and the island of Guam are maintained under the supervision of the naval commandants by means of allotments made from the appropriations for the Lighthouse Service. Reports have been received from naval officers in local charge indicating that the aids have been properly maintained, at an approximate annual expense as follows: Guantamano, \$3,971.19; Samoa, \$949.76; Guam, \$211.53.

VIRGIN ISLANDS.

The lighthouse work in the islands of St. Thomas, St. Croix, and St. John, with the outlying rocks and islets, formerly constituting the Danish West Indies and now the Virgin Islands of the United States, was by Executive order, dated July 20, 1917, placed under the Lighthouse Service, following the customary procedure in such cases.

The care and maintenance of the aids were formally transferred to the Lighthouse Service by the military governor of the islands on August 16, 1917.

An estimate of \$50,000 has been submitted to Congress for establishing necessary additional aids for these islands. These additional aids were authorized by act of June 20, 1918, but no appropriation was made therefor.

ENGINEERING AND CONSTRUCTION.

The most important item of construction work completed during the fiscal year was the new light station on Navassa Island, West Indies. This work is described on page 633. Thirty-two aids, including 23 lighted beacons and buoys and 9 unlighted buoys, were established at the approaches to the Cape Cod Canal, Mass.

Improvement of aids to navigation at Ashtabula Harbor, Cleveland Harbor, and Toledo Harbor, Ohio, was completed. This work is described on pages 634 and 635. Other important works in progress at the close of the fiscal year included Woods Hole (Mass.) lighthouse

depot, completing electric lighting and equipment; aids to navigation, Hudson River, N. Y.; aids to navigation, East River, N. Y.; Great Salt Pond Light Station, R. I., improvements; Hunts Point, N. Y., light and fog signal; Staten Island lighthouse depot, N. Y., improvements; aids to navigation, Delaware River, Pa. and Del.; aids to navigation, St. Johns River, Fla.; repairing and rebuilding aids to navigation damaged by storm and ice, Atlantic coast; repairing and rebuilding aids to navigation damaged by hurricane, Gulf coast and Mississippi River below New Orleans; repairing and improving aids to navigation, Florida Reefs, Fla.; improving aids to navigation, Lorain Harbor and Conneaut Harbor, Ohio; improving aids to navigation, Detroit River, Mich.; establishing a light and fog signal, Sand Hills, Mich.; establishing a light and fog signal at White Shoal, Mich.; rebuilding Chicago Harbor Light Station, Ill.; improving aids to navigation, Alaska; improving aids to navigation, Puget Sound, Wash.; improving aids to navigation, Washington and Oregon. These works are described on pages 599 to 607.

IMPROVEMENT OF APPARATUS AND EQUIPMENT.

An occulting mechanism, actuated by the heat of the flame, for use in post lanterns, was given further test, with results indicating the development of an automatic occulting post lantern that will give satisfactory results.

A device for handling sinkers, ballast balls, etc., was installed at Key West lighthouse depot. This device consists of a pair of heavy wheels mounted on a bowed axle provided with a crane-hook chain sling, mounted at the center of the axle.

An improvement has been made in the method of placing riprap protection at light stations by depositing the stones regularly instead of at random, packing tightly, and filling up the crevices with smaller stone, and in work where large deposits are required the annular mass of large stones is first deposited as above, after which the inner space is filled with smaller stone.

For testing purposes two spruce spar buoys were placed in the comparatively warm waters of Vineyard Sound, Mass., for observation as to action of the teredo, etc. After a year in the water these buoys do not appear to be water-soaked or worm-eaten more than cedar buoys and so far have given satisfactory results.

The substitution of cast-iron horns for copper horns in connection with compressed-air sirens has proved satisfactory where tried.

The use of a thermostat designed to warn keepers by ringing a bell when undue fluctuations occur in operating oil-vapor lamps has been extended with satisfactory results.

Experiments have been conducted with success at the general depot with a view to the manufacture of 375-millimeter (about 15 inches) pressed-glass buoy lenses for use in place of the present expensive cut-glass lenses.

The new type L gas and whistling buoy, designed for use in channel work and in locations where a larger buoy would be too heavy, has proven satisfactory.

The work of standardization has been extended during the past year as heretofore, and in many cases articles and parts have been completely standardized and are now interchangeable, so that repair parts may be kept on hand for issue at short notice.

Kerosene for fuel, replacing coal, was in use in the galley range aboard several vessels with good results and has been found more satisfactory than coal.

The continued use of oil engines in place of steam for power and for operating fog signals has demonstrated the greater economy and convenience of such apparatus, and the use of these engines is being extended as boilers now in service become unfit for further use.

ORGANIZATION OF THE LIGHTHOUSE SERVICE.

The general organization of the Service remained unchanged during the fiscal year, except that the designations of officers in charge of lighthouse districts, formerly known as "lighthouse inspectors," were by section 7 of the act approved June 20, 1918, changed to "superintendents of lighthouses." The employees formerly designated superintendents were changed by Department order to first assistant superintendents, or assistant superintendents. The duties and responsibilities of these officers and employees remain the same as previously.

PERSONNEL.

The following table gives the number of employees (all authorized positions, including some vacancies) of the Lighthouse Service at the end of the fiscal year and a comparison of the totals with those for the previous fiscal year:

EMPLOYEES IN THE LIGHTHOUSE SERVICE ON JUNE 30, 1918.

District.	Inspectors, engineering force, draftsmen, aids, appointed foremen, and mechanics.	Clerks, messengers, janitors, and office laborers.	Depot keepers and assistants, including laborers.	Light keepers and assistants.	Laborers and laborers-in-charge of lights (appropriation "Salaries, keepers of lighthouses").	Laborers-in-charge of post lights and buoys (appropriation "General expenses").	Custodians of reservations.	Officers and crews on tenders and light vessels.	Field force for construction and repair (registered).	Field force for construction and repair (unregistered).	Total.
Bureau.....	13	25	1	114	2			71	10	9	28
First.....	3	6	1	78	10			290	3	11	216
Second.....	4	7	2	78	32			277	17	44	334
Third.....	21	31	16	178	56			32	5	6	124
Fourth.....	5	5	3	54	97			278	14	3	338
Fifth.....	10	10	41	166	20			139	4	12	260
Sixth.....	5	7	2	55	10			33	4	3	94
Seventh.....	2	3	1	40	1			7			
Eighth.....	2	9	15	110	32	25		108	9	46	370
Ninth.....	2	5	1	40	9			24	15	6	102
Tenth.....	7	5	2	68	1			28	7	27	146
Eleventh.....	9	6	6	159	10	2	1	113	14	52	373
Twelfth.....	8	6	4	152	18	2	1	95	4	15	306
Thirteenth.....	1	2				321		19			343
Fourteenth.....	1	2				535					538
Fifteenth.....	1	2				370		20			369
Sixteenth.....	5	4	1	32		21		48	1	7	119
Seventeenth.....	7	6	4	78	15	120		108	4	3	345
Eighteenth.....	6	7	7	107	14	5		93	3	10	261
Nineteenth.....	4	3	1	26	2			30	2	5	73
Total, 1918.....	120	150	107	1,457	256	1,524	14	1,736	276	259	5,899
Total, 1917.....	122	149	103	1,464	242	1,526	13	1,704	273	200	5,796
Increase.....		1	4		14		1	32	3	59	103
Decrease.....	2			7		2					

Up to June 30, 1918, a total of 123 persons from the Lighthouse Service, exclusive of those transferred by Executive order, had entered the Army or Navy, making with those transferred a grand total of 1,255 employees who have entered the military services, or 22 per cent of the normal force of the Lighthouse Service.

ADMINISTRATION METHODS AND ECONOMIES.

By a decision of the Bureau of War Risk Insurance the personnel of Lighthouse Service transferred to the service and jurisdiction of the Navy and War Departments are within the terms of the war risk insurance act of October 6, 1917.

The Regulations for the Lighthouse Service were revised and reprinted.

A compilation of data relating to hours of fog and its relative prevalence at different seasons of the year was made from information on file, based on the regular records at fog-signal stations. Records of fog have been kept in a systematic manner since 1885 and are now sufficiently complete to provide material for study of this matter from both meteorological and engineering standpoints.

Careful attention was given during the fiscal year both by the Department and the Bureau to conditions affecting pay and subsistence, particularly on board vessels. A more detailed statement in reference to this question is made on page 583.

With a view to lessening office work, the Department granted authority for discontinuing certain routine work in the Bureau's office in connection with appointments, etc. The Department also approved a plan for simplifying methods in connection with the appointment, promotion, etc., of keepers of lighthouses and laborers attending lights.

As a measure of economy, the use of cotton towels for the Lighthouse Service has been adopted in place of the linen towels heretofore used.

The President, by Executive order of October 13, 1917, transferred about 1.22 acres of land on Sand Island, Oahu, Hawaii, from the War Department to the Department of Commerce, for lighthouse-depot purposes, and by Executive order of October 18, 1917, reserved Huckleberry Island, in Padilla Bay, Wash., containing 11.74 acres, for lighthouse purposes.

At the Southern Commercial Congress, held in New York City October 13 to 18, 1917, a universal flashing lens and lantern, eight-day post lantern, electric lamp substituting device, and other features of interest pertaining to the Lighthouse Service were displayed.

Great effort was made to keep lights on the Great Lakes in commission as long as possible after the usual time for the close of navigation, in compliance with the desires of maritime interests, but such severe weather conditions set in about December 8 that practically all Lake traffic was brought to a standstill within a week, notwithstanding the efforts made to keep the lights in commission and the channels open for navigation.

Valuable work was accomplished by lighthouse tenders in keeping channels open for navigation along the North Atlantic coast during the unusually severe freezing weather of the past winter.

The employees of the Lighthouse Service have subscribed liberally to the three Liberty loans and the war savings stamps issue. They have also displayed commendable activity in the food-conservation campaign, and much work has been done in the way of raising vegetables, canning fish, and in similar activities.

Systematic inspections have been continued in the various lighthouse districts of technical work, business methods, and property accounts

COST-KEEPING SYSTEM AND RESULTS.

A standard method of cost keeping has been continued in effect throughout the fiscal year.

The costs are based on the actual expenditures during the fiscal year, whether of money or supplies. The figures given show all disbursements made by the Lighthouse Service, including expenditures on account of vessels, etc., temporarily transferred to the Navy Department, but do not include expenditures made direct by the Navy Department on account of such vessels, etc. The information from this cost-keeping system is useful in preparing estimates, planning work, effecting economies, and comparing the efficiency of different districts, vessels, light stations, apparatus, methods, etc.

A generalized summary of costs for the fiscal year ended June 30, 1918, follows, as derived from this cost-keeping system. Notwithstanding the most careful and painstaking efforts to economize in every direction, the continued extraordinary advance in the price of labor and materials is clearly shown in the increased costs reported for practically all features.

SUMMARY OF COSTS, LIGHTHOUSE SERVICE, FISCAL YEAR ENDED JUNE 30, 1918.

[Amounts are stated to nearest even dollar, causing occasional minor discrepancies in totals. Differences from total expenditures reported elsewhere is due to inclusion of Bureau salaries, printing expenses, and adjustment of inventories of articles furnished from stock.]

TOTAL COSTS OF PRINCIPAL FEATURES.

Feature.	Maintenance expenses.					Betterment expenses.			Grand total.	Per cent.
	Salaries.	Subsistence.	General supplies.	Incidental expenses.	Total.	Repairs and improvements.		New works.		
						Labor.	Materials and supplies.			
Administration a.....	\$331,322		\$57,302	\$2,902	\$391,526				\$391,536	6
Distributive charges b.....	1,080,771	\$232,533	580,335	29,000	1,942,680	\$178,259	\$175,925	\$45,903	\$400,087	37
Aids to navigation c.....	1,720,903	275,462	508,699	20,227	2,523,271	202,433	367,470	461,417	1,031,320	57
Total.....	3,133,006	527,995	1,144,386	52,129	4,857,497	380,692	543,395	507,321	1,431,407	100

TOTAL COSTS OF DETAILED FEATURES.

Offices.....	\$331,332		\$89,913	\$2,902	\$404,147			\$404,147	6
Depots.....	206,568		97,978	21,249	325,795	\$29,780	\$27,443	\$71,835	6
Tenders:									
Large.....	236,029	\$98,443	145,459	2,004	481,935	26,717	28,719	529,446	8
Medium.....	554,310	167,683	201,080	5,693	1,058,625	113,347	113,349	1,285,073	24
Small.....	53,874	16,432	25,238	179	95,724	8,415	8,416	113,712	1
Total.....	874,203	262,553	469,796	7,751	1,604,284	148,479	148,482	1,892,243	33
Light vessels:									
Exposed.....	204,712	46,246	52,890	507	305,347	23,492	23,492	355,761	5
Moderately exposed.....	132,183	33,305	22,659	1,370	189,521	27,086	27,086	246,110	4
Relief.....	78,900	18,695	22,640	185	114,420	16,086	16,086	144,615	2
Lakes.....	60,413	17,348	13,220	368	91,453	5,948	5,949	103,010	2
Total.....	470,208	115,594	110,909	2,460	702,270	72,564	72,565	854,497	13

a Includes offices, except expenses of publications.

b Includes depots and tenders; also item excepted above, charged to supplies.

c Includes light vessels, light stations, minor fixed aids, and buoy.

SUMMARY OF COSTS, LIGHTHOUSE SERVICE, FISCAL YEAR ENDED JUNE 30, 1918—Continued.

TOTAL COSTS OF DETAILED FEATURES—Continued.

Feature.	Maintenance expenses.				Betterment expenses.				Grand total.	Per cent.	
	Salaries.	Subsid- ence.	General supplies.	Incidental expenses.	Total.	Repairs and improve- ments.					Total.
						Labor.	Materials and supplies.				
							New works.				
Light stations:											
First order.....	\$125,501	\$19,768	\$33,598	\$1,314	\$180,171	\$6,239	\$8,314	\$6	\$13,712	\$198,883	3
Second order.....	55,832	8,916	18,243	273	83,253	3,060	2,753	16,838	22,641	105,894	2
Third order.....	110,481	17,929	38,114	2,787	169,314	14,919	16,312	1,098	32,269	201,573	4
Three and one-half order.....	24,407	4,376	6,981	89	36,853	1,307	4,818	.....	6,125	41,977	1
Fourth order.....	389,450	64,546	116,022	2,740	562,758	28,645	30,540	253,613	312,798	865,556	14
Total.....	685,661	115,535	212,945	7,208	1,021,345	53,323	62,787	271,476	387,536	1,408,883	24
Minor fixed aids:											
Fifth order.....	94,205	17,115	23,281	244	134,844	9,374	6,631	(498)	15,710	150,554	2
Sixth order.....	43,644	7,541	11,463	66	62,713	5,004	4,784	80	9,888	72,601	1
Beacon lanterns.....	67,623	7,400	10,996	486	86,505	6,557	9,539	55,238	70,331	156,704	2
Post lights.....	235,901	.....	31,274	1,126	268,311	7,784	13,149	2,248	21,281	279,592	4
Other lights.....	123,666	9,277	41,819	4,615	179,367	30,875	57,912	116,769	205,556	384,923	6
Daymarks, etc.....	.....	.....	921	570	1,491	1,444	2,082	1,768	5,494	6,983	0
Total.....	565,034	41,333	100,694	7,119	722,109	58,188	94,297	175,715	328,200	1,051,319	15
Buoys:											
Lighted.....	.....	.....	41,793	2,128	43,921	11,833	78,615	3,317	94,285	138,176	2
Unlighted.....	.....	.....	31,365	1,317	32,682	6,506	59,256	3,312	69,073	101,753	1
Total.....	.....	.....	73,158	3,445	76,573	18,338	137,871	7,129	163,358	239,931	3
Grand total.....	3,133,006	527,995	1,144,386	52,129	4,857,497	380,692	543,395	567,321	1,451,497	6,288,904	100

SUMMARY OF COSTS, LIGHTHOUSE SERVICE, FISCAL YEAR ENDED JUNE 30, 1918—CON.

AVERAGE COSTS OF SELECTED FEATURES.

Average cost of—	Salaries.	Subsistence.	Illuminants.	Fuel.	Other supplies.	Includen- tals.	Total mainte- nance.	Re- pairs and im- prove- ments.	Total
District office, exclusive of third.	\$12,512				\$1,563	\$74	\$14,148		\$14,148
District depot, exclusive of third.	5,379				2,795	674	9,348	\$1,545	10,893
Large tender, Pacific.	24,266	\$7,175		\$14,253	5,784	46	51,524	6,300	57,824
Large tender, Atlantic.	23,161	6,624		7,345	3,539	303	40,973	4,705	45,678
Medium tender.	18,628	5,355		6,538	2,986	176	33,683	7,419	41,102
Exposed light vessel.	10,235	2,462	\$80	1,571	967	25	15,340	2,349	17,689
Moderately exposed light vessel.	6,294	1,586	85	430	564	65	9,025	2,574	11,599
Lake light vessel.	4,647	1,334	32	584	408	31	7,087	914	7,961
First-order light stations with powerful fog signals.	2,771	426	123	550	328	32	4,280	355	4,585
First-order light stations without fog signals.	1,968	316	84	114	226	21	2,728	202	2,930
Fourth-order light stations with powerful fog signals.	1,578	282	65	388	289	18	2,618	265	2,883
Fourth-order light stations without fog signals.	770	133	35	55	90	7	1,090	109	1,199
Lens lantern.	215	24	15	8	11	1	274	53	327
Minor light, river districts.	91		3		3		97	1	98
Minor light, other districts.	121		11		6	1	139	29	168
High-pressure acetylene light.	42	3	20	4	6	1	76	108	184
High-pressure acetylene buoy.			24		34	2	60	54	114
Oil-gas buoy.			35		26	5	66	35	101

a Figures do not include cost of establishment of new aids.

b Figures include transportation charges of all kinds, such as freight on new buoys, etc.

c Figures do not include renewal of appendages.

APPROPRIATIONS AND EXPENDITURES.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1919 were \$6,150,430, exclusive of an allotment of \$175,000 made by the President from the fund for national security and defense, being \$811,750 in excess of those for the preceding fiscal year. The appropriations for special works made for the fiscal year 1919 amounted to \$723,000.

The average appropriations for special works for the 10 preceding years, 1909 to 1918, inclusive, amounted to \$635,133.

The detailed estimates for the fiscal year 1920 are given on page 620. The total amount for general maintenance is \$1,603,200 more than the appropriation for the present year. Particular attention again is invited to the urgent need of the Lighthouse Service for additional funds. The increase in the cost of all materials has continued, salaries and wages have been uniformly advanced, and in order that the Service may be maintained at a proper standard of efficiency a corresponding increase in its appropriations is necessary. The Bureau desires to lay special stress on this matter, and under a separate heading includes a more detailed statement with reference to pay on vessels.

An increase of \$3,420 over the appropriation for the preceding fiscal year is submitted in the estimate for the Bureau of Lighthouses in Washington in order to enable the Bureau to meet the general advance throughout the country in the pay of technical employees, and to keep these positions and the lower paid clerical positions in the Bureau competently filled.

Estimates for 20 special works have been submitted, aggregating \$2,737,775, considering only group 1, of which items amounting to \$1,608,500 are authorized by law. This estimate is \$2,014,775 more than the appropriation for special works for the preceding year, and includes a number of important works for which estimates were submitted last year, but which were not included in the appropriations. The estimates include three new lighthouse tenders, one new light vessel, three new lighthouse depots, four items for establishing or improving aids in general localities, five items for a new system of harbor or channel lights and other aids, one item for establishing a light and fog-signal station, five items for improvement of lighthouse depots, and one item for light-keeper's dwellings.

In selecting and submitting estimates for those special works believed to be most important, there were considered estimates submitted by officers in the various districts and others for new lighthouse and ship construction aggregating about \$4,800,000. Many items not included in the estimates for this year are thought to be meritorious, and the more important of them are included in group 2 of the estimates for special works, submitted for consideration as the resources of the Government permit them to be taken up. Explanation of the necessity for each of the items of special works is included with the estimates.

The tables following give comparisons of appropriations and expenditures for the Lighthouse Service, beginning with the fiscal year 1915 and including the estimates for 1920.

APPROPRIATIONS, LIGHTHOUSE SERVICE, FISCAL YEARS 1915-1918, WITH ESTIMATES FOR 1920.

[The salaries and allowances of officers of the Army on duty with the Lighthouse Service are not included in this table.]

Item.	Appropriations.					Estimates 1920.
	1915	1916	1917	1918	1919	
MAINTENANCE.						
Salaries, Bureau of Lighthouses	\$64,030	\$64,030	\$64,030	\$64,030	\$65,430	\$69,030
Salaries of keepers of lighthouses	940,000	940,000	940,000	940,000	940,000	1,321,500
General expenses, Lighthouse Service	2,775,000	2,775,000	2,790,000	2,850,000	3,500,000	4,000,000
Salaries, lighthouse vessels	997,600	1,010,000	1,070,000	1,104,650	1,265,000	1,890,080
Salaries, Lighthouse Service	375,000	375,000	375,000	380,000	380,000	433,000
Retired pay, Lighthouse Service						50,000
Total for maintenance	5,151,630	5,164,030	5,239,030	5,338,680	6,150,430	7,753,630
Unexpended balances (obligations estimated)	53,424	47,171	67,377			
SPECIAL WORK.						
New light and fog-signal stations	63,000		193,000	155,000	80,000	140,000
Light vessels				280,000		160,000
Lighthouse tenders		250,000	20,000	210,000		600,000
Keepers' dwellings						75,000
Improvement of aids	50,000		736,000	613,000	355,000	837,775
Lighthouse depots	23,000		50,000	21,000	288,000	926,000
Total for special works	136,000	250,000	999,000	1,279,300	723,000	2,737,775
Total maintenance and special works	5,287,630	5,414,030	6,238,030	6,617,980	6,873,430	10,491,405

EXPENDITURES FROM APPROPRIATIONS, LIGHTHOUSE SERVICE, FISCAL YEARS
1914-1918.

[Actual expenditures, regardless of year of appropriation.]

Expenditures.	1914	1915	1916	1917	1918
For maintenance.....	\$5,166,609	\$5,111,121	\$5,002,706.25	\$5,220,473.07	\$6,246,088.83
For special works.....	538,338	500,516	748,833.50	651,298.99	499,633.24
Total.....	5,704,947	5,611,637	5,751,539.75	5,871,772.06	6,745,722.07

In addition to the appropriations listed above, funds have been received from the Navy Department, or are in course of settlement by transfer, in reimbursement of expenditures and obligations by the Lighthouse Service during the fiscal year 1918, on account of vessels and stations temporarily transferred to that department, and for which the appropriations of the Lighthouse Service were to that extent insufficient, as follows:

To credit of general expenses, Lighthouse Service, 1918.....	\$434,412.13
To credit of salaries, lighthouse vessels, 1918.....	227,564.48
To credit of salaries of keepers of lighthouses, 1918.....	8,233.15
Total.....	670,209.76

Reimbursement for similar reasons was received from the War Department for expenditures and obligations during the fiscal year 1917 on account of vessels temporarily transferred to that department, and omitted from last year's annual report, as follows:

To credit of general expenses, Lighthouse Service, 1917.....	\$68,922.19
To credit of salaries, lighthouse vessels, 1917.....	74,528.73
Total.....	143,450.92

There were no reimbursements for the fiscal year 1917 from the Navy Department, nor for 1918 from the War Department.

DEPOTS.

The Lighthouse Service maintains 39 depots in the various districts for the storage and distribution of supplies and for other purposes. While these depots are not in themselves aids to navigation, they bear such a direct and important relation to the efficient maintenance of the latter that it is essential to provide them with adequate facilities. The sundry civil act of July 1, 1918, appropriated \$85,000 for a depot for the second lighthouse district, and \$90,000 for a depot for the sixteenth lighthouse district, and contained an appropriation of \$53,000 for improvements at the Detroit, Mich., Lighthouse Depot. A number of items for depots are submitted in the estimates, some of which are repeated from previous annual reports, and five of which are authorized by law, though no appropriation has yet been made. Particular attention is invited to these cases, as follows:

In the nineteenth district the headquarters of the Lighthouse Service are at Honolulu, and storage facilities are either rented or granted by the courtesy of other branches of the Government. The establishment of a permanent depot in this district would facilitate the work of the Service, and estimates are submitted for that purpose. The act of August 28, 1916, authorized the construction of a perma-

ment depot at a limit of \$90,000, but no funds were appropriated for this object.

Subsequent to the close of the fiscal year, allotment of \$175,000 from the fund for national security and defense was made by the President on the recommendation of the Secretary of Commerce, for improvements at the general lighthouse depot at Tompkinsville, N. Y., with particular reference to cooperation work with the Navy Department.

In the fifth district the present principal depot at Portsmouth, Va., is inadequate both in area and in water front, considering the size of the district and the number of lighthouse vessels to be accommodated. Estimate is submitted for enlarging this depot or establishing a new one. This work was authorized by the act of June 20, 1918.

The need for a depot at New Orleans, La., in the eighth district, has long been felt, and much unnecessary storage and lighterage expense has been incurred on this account. The Treasury Department has authorized the use of a portion of the United States marine hospital reservation at New Orleans, La., as a site for a lighthouse depot. An estimate for the construction of a depot is submitted. The work was authorized by act of June 20, 1918.

The present depot at Milwaukee, Wis., is practically surrounded by coal yards, and the coal dust is objectionable. Consideration is being given to obtaining a more suitable site.

The act of June 12, 1917, appropriated \$21,000 for improvements of the offices and laboratory at the general depot. Plans and specifications for this work were prepared and bids invited. The bids received were rejected, being in excess of the appropriation.

In the following districts provisions should be made for improved depot facilities:

An estimate is submitted for enlarging the machine shop at the general lighthouse depot at Tompkinsville, N. Y. The present machine shop is so constructed as to be unadaptable for the work it is now called upon to do, and it must be extended to be efficient for the great variety of work at this depot. This work was authorized by act of June 20, 1918, in the sum of \$30,000.

An estimate for improvement of the wharves at the general depot is also submitted, the work having been authorized by act of June 20, 1918, in the sum of \$65,000.

An estimate for a dry dock at the general depot is also submitted in group 2. The congested conditions prevailing at private shipyards and navy yards make it impossible to attend to the docking of lighthouse vessels at the proper intervals. Such a dock also would be of great value to other maritime services of the Department, and it is believed that considerable economy would thus result to the Government as a whole.

In the seventh district at Key West, Fla., the present depot property is on the grounds of the naval station and is surrounded by coal piers. The location is objectionable from the standpoint of caring for lighthouse supplies in a proper manner as well as interfering with the normal growth of the naval station. An estimate for a new depot, to relieve this situation, is submitted.

The new lighthouse depot at Charleston, S. C., for which an appropriation was made by the act of October 22, 1913, has been completed so far as funds permitted and was occupied regularly for the

first time on August 1, 1916. Further improvements at Charleston Depot are needed, for which an estimate is submitted. The present quarters at the Goat Island Lighthouse Depot, Cal., consist of two old frame dwellings, and are inadequate, unsanitary, and poorly arranged. Two families occupy one cottage of seven rooms and three families occupy another cottage of eight rooms. An estimate is submitted for constructing two dwellings of modern design and proper location adjacent to the depot.

By act of July 1, 1918, making appropriations for the naval service for the fiscal year 1919, the lighthouse depot at St. Joseph, Mich., was transferred to the Navy Department for naval purposes. This depot had been occupied by the Navy Department under revocable permit dated June 25, 1917, its use being no longer required for lighthouse purposes.

LIGHTHOUSE TENDERS.

The tenders of the Service have been employed to good advantage during the year. The 51 vessels which have been in commission have steamed a total of about 491,000 nautical miles in their work of supplying light stations, maintaining the buoyage system, transporting construction materials, and carrying the officers and employees of the Service to their stations or on inspection duty.

An appropriation of \$20,000 was made by the act of July 1, 1916, for a light-draft tender and barge for use in establishing and maintaining aids along the intercoastal waterways of Texas and Louisiana. Proposals have been twice advertised for this equipment without results. Therefore it has been necessary to defer action until conditions become more favorable.

With the increase in the number of aids to navigation and the deterioration of older vessels, it will be necessary to construct on an average one or two new tenders each year. The act of June 12, 1917, appropriated \$150,000 to replace the tender *Gardenia*, which has been surveyed and laid up as being of no further use to the Service. Bids received for this work being greatly in excess of the appropriation were rejected.

Estimates have been submitted for new lighthouse tenders to replace the present tenders *John Rodgers*, *Jessamine*, and *Holly*, or for general service, as may be found most desirable, at a cost of \$600,000. The vessels mentioned are all old, unseaworthy, side-wheel steamers, which should be laid up as soon as arrangement can be made. The act of June 20, 1918, authorized this work, but no appropriation has been made.

A workin barge for use on the Hudson River was practically completed.

The following tenders have either been extensively overhauled or such work has been started during the fiscal year 1918: *Crocus*, *Arbutus*, *Heather*, *Kukui*, *Larkspur*, *Camellia*, *Holly*, *Magnolia*, *Sumac*, *Woodbine*, and *Snowdrop*.

It is probable that during the current year extensive overhaul will be completed or undertaken on the following tenders: *Mangrove*, *Maple*, *Iris*, *Marigold*, *Amaranth*, *Sunflower*, *Mayflower*, *Mistletoe*, and *Magnolia*.

The following was the number of tenders of the Lighthouse Service on June 30 of the years specified, omitting vessels not having regular

crews and those less than 50 feet in length: 1910, 51; 1911, 46; 1912, 45; 1913, 44; 1914, 45; 1915, 46; 1916, 47; 1917, 51; 1918, 51. On June 30, 1918, the following was the status of the tenders: In actual service, 44; undergoing repairs, 7.

LIGHT VESSELS.

The Lighthouse Service maintains light vessels on 52 stations and has for this purpose 67 light vessels, of which 15 are relief vessels. Some of these vessels are old, 3 having been built over 50 years ago; 8 having been built over 60 years ago; one is 69 years old. Some of the older vessels are in a condition which does not warrant extensive repairs.

The unusual severity of the past winter with the accompanying ice conditions resulted in the total loss of Cross Rip Light Vessel No. 6, Mass., with all on board, consisting of one officer and five men.

On the afternoon of February 4, 1918, a large field of floating ice tore the vessel from her moorings on her station in Vineyard Sound, carrying her seaward, where she disappeared. Every effort was made by Lighthouse Service and Navy vessels to reach the light vessel and render assistance, but without success after several days' search, and the vessel is believed to have foundered. Light vessel No. 45, marking the lower entrance to the 35-foot channel, Chesapeake Bay, Va., was dragged from her station by floating ice on January 5, 1918, and stranded on the Inner Middle Ground Shoal abreast of Fishermans Island, Chesapeake Bay entrance, Va., where she was abandoned by the crew, who reached shore over the ice with difficulty. The vessel was rescued and taken in tow by the tender *Cypress* on January 17, 1918, and brought to Portsmouth, Va., and later to the works of the Colonna Shipbuilding Co., Berkley, Va., for repairs. On March 3, 1918, the vessel was badly damaged by fire, which had its origin on another vessel, berthed near the light vessel. Only the prompt actions of the officers and crew of the light vessel and the fire department saved the vessel from total loss.

A board of survey was ordered, which after a thorough inspection of the vessel on July 10, 1918, submitted a report recommending that the light vessel be condemned and sold, being beyond economical repair, and of no further use to the Government.

During the fiscal year 67 light vessels were in commission. New vessels under construction are light vessels No. 99 and No. 103, for duty on the Great Lakes.

The act of June 20, 1918, authorized \$760,000 for tenders and light vessels, which included a new light vessel for the Gulf coast, but no appropriation was made therefor. An estimate for this object is submitted.

The act of June 12, 1917, appropriated \$130,000 for a light vessel for Cape Charles, Va., or for general service, plans and specifications for which are nearly completed.

The following light vessels have either been extensively overhauled or such work has been started during the last fiscal year: No. 2, No. 13, No. 20, No. 39, No. 49, No. 66, No. 69, No. 80.

It is probable that during the current fiscal year extensive overhaul will be completed or undertaken on the following light vessels: *No. 2, No. 11, No. 16, No. 51, No. 68, No. 70, No. 97.*

The following was the total number of light vessels and stations on June 30 of the years named:

Year.	Light vessels.	Light-vessel stations.	Year.	Light vessels.	Light-vessel stations.
1910.....	68	54	1915.....	66	53
1911.....	63	51	1916.....	66	53
1912.....	65	51	1917.....	68	53
1913.....	67	53	1918.....	67	52
1914.....	66	52			

Of the present light vessels 38 have self-propelling machinery and 27 are provided only with sail power. Two have no means of propulsion.

On June 30, 1918, the following was the status of the light vessels: Regular vessels on station, 41; relief vessels on station, 10; relief vessels at depots, 4; regular vessels under repair, 10; relief vessels under repair, 1; regular vessels laid up, 1; relief vessels laid up, 0.

SALARIES AND WAGES ON LIGHTHOUSE VESSELS.

The greatest difficulty encountered in the efficient maintenance of the service during the past three years has been the question of pay on lighthouse tenders and light vessels. As is well known, abnormal shipping conditions have been created by the European war, and former standard rates of pay on vessels have been completely discarded.

The schedules of pay established from time to time by the United States Shipping Board for officers and crews of vessels, while they do not apply directly to vessels of the Lighthouse Service, are considered standard wages in the localities in which they have been placed in effect, and it has been necessary to adjust the pay of complements of lighthouse vessels to conform therewith as far as appropriations admit, both in justice to employees and in order to keep up a proper efficiency. The wage scale for certain members of deck and engine departments, announced by the Shipping Board on May 18, 1918, for vessels sailing from Atlantic and Gulf ports of the United States is now being paid to crews of lighthouse vessels, and licensed officers were granted increases to meet, as far as possible, new rates authorized in the month of June, 1918, by the Shipping Board for this class of persons. This action has necessitated large increases in the estimates for salaries on vessels of the Lighthouse Service, and estimate for additional increase will be submitted in order to bring the pay of officers of the vessels more nearly up to current rates of pay in the mercantile marine.

REPORT OF OPEN-MARKET PURCHASES.

In compliance with the act of June 17, 1910, there is submitted separately as a part of this report a list of purchases of materials and supplies for the Lighthouse Service made without obtaining bids under public advertisement, with the reasons for so purchasing.

SPECIAL LEGISLATION NEEDED.

The act of June 20, 1918, provides for optional retirement at the age of 65 years, after 30 years of active service, and compulsory retirement at the age of 70 years of all officers and employees engaged in the field service or on vessels of the Lighthouse Service, except persons continuously employed in district offices or shops. This legislation will be of much benefit to the Service, but in order that higher efficiency may be obtained in the administration of the service, retirement provisions should be enacted for the relief of persons included in the above classes who, by reason of disability incident to their work, and distinct from disability caused by injury received in the line of duty, for which compensation is now provided by law, have lost their efficiency for active work before reaching the age, or having the length of service, required under existing law.

A modification of the act of June 20, 1918, is also deemed desirable so far as it requires compulsory retirement at 70 years of age. The Bureau is of the opinion that the interests of the Government would be served more effectively by substituting for compulsory retirement of persons who have reached 70 years of age a provision for the retirement of such persons in the discretion of the Secretary of Commerce.

The Bureau is strongly of the opinion that the interests of the Government would be further benefited, in the attainment of a higher degree of efficiency, as well as in affording justice to deserving employees, by the enactment of legislation providing for a system of general retirement for the civil employees of the Government, including office and shop employees of the Lighthouse Service, the need of such legislation being particularly apparent in the work of this Service.

The statistics as to the various classes of aids to navigation and fuller details on many of the subjects mentioned in this report will be found in the pages following.

Respectfully,

GEORGE R. PUTNAM,
Commissioner of Lighthouses.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

STATISTICS AND ESTIMATES.

LIST OF OFFICERS OF THE BUREAU OF LIGHTHOUSES AND THE LIGHTHOUSE DISTRICTS.

OFFICERS OF THE BUREAU OF LIGHTHOUSES ON JUNE 30, 1918.

George R. Putnam.....Commissioner of Lighthouses.
 John S. Conway.....Deputy Commissioner.
 H. B. Bowerman.....Chief Constructing Engineer.
 Edward C. Gillette.....Superintendent of Naval Construction.

Principal Assistant Engineer, Rudolph Zirpel.
 Superintendent on general duty, E. M. Trott.
 Chief Clerk, Thaddeus S. Clark.
 Examiner, Thomas Flood.

SUPERINTENDENTS OF LIGHTHOUSE DISTRICTS JULY 1, 1917, TO JUNE 30, 1918.

District.	Name.	From—	To—
1st.....	C. E. Sherman.....	July 17, 1911	
2d.....	R. H. Goddard.....	June 27, 1912	
3d.....	J. T. Yates.....	June 20, 1912	
4th.....	T. J. Rout.....	Mar. 1, 1912	
5th.....	H. D. King.....	Jan. 28, 1915	
6th.....	H. L. Beck.....	Jan. 28, 1915	
7th.....	W. W. Demeritt.....	Aug. 22, 1913	
8th.....	B. B. Dorry.....	June 6, 1912	
9th.....	C. A. Lamy.....	Aug. 7, 1912	Jan. 6, 1918
	F. C. Hingsburg.....	Jan. 28, 1918	
10th.....	Roscoe House.....	June 4, 1912	
11th.....	E. L. Woodruff.....	Aug. 19, 1912	
12th.....	L. M. Stoddard.....	Aug. 16, 1912	Apr. 30, 1918
	C. H. Hubbard.....	May 1, 1918	
13th.....	Maj. Gen. A. Mackenzie, U. S. Army, retired.....	May 29, 1917	
14th.....	Col. Lansing H. Beach, Corps of Engineers, U. S. Army.....	Aug. 10, 1915	
15th.....	Lt. Col. C. S. Smith, Corps of Engineers, U. S. Army.....	June 25, 1917	Sept. 17, 1917
	Brig. Gen. Wm. H. Bixby, U. S. Army, retired.....	Sept. 17, 1917	
16th.....	W. C. Dibrell.....	Aug. 22, 1913	
17th.....	Robert Warrack.....	Feb. 1, 1915	
18th.....	H. W. Rhodes.....	July 6, 1912	
19th.....	A. E. Arledge.....	Sept. 3, 1912	

JURISDICTION OF LIGHTHOUSE SERVICE.

The United States Lighthouse Service is charged with the establishment and maintenance of aids to navigation and with all equipment and work incident thereto on the sea and lake coasts of the United States, on the rivers of the United States so far as specifically authorized by law, and on the coasts of all other territory under the jurisdiction of the United States, with the exception of the Philippine Islands and Panama. The total length of coast line and rivers under the United States Lighthouse Service, measured by steps of 3 miles, is approximately 47,300 miles.

LIMITS OF LIGHTHOUSE DISTRICTS AND ADDRESSES OF SUPERINTENDENTS OF LIGHTHOUSES.

District.	Limits of district.	Address of superintendents.
1st.....	Waters of Maine and New Hampshire.....	Y. M. C. A. Building, Portland, Me.
2d.....	Waters of Massachusetts.....	Customhouse, Boston, Mass.
3d.....	Waters of Rhode Island, Connecticut, New York, and New Jersey northward of Cape May.	Tompkinsville, N. Y.
4th.....	Waters of Delaware seacoast and Delaware Bay and River.	Post Office Building, Philadelphia, Pa.
5th.....	Waters of Maryland, Virginia, and North Carolina to and including New River Inlet, N. C.	New Customhouse, Baltimore, Md.
6th.....	From New River Inlet, N. C., to Hillsboro Inlet, Fla.	Old Post Office Building, Charleston, S. C.
7th.....	Waters of Florida from Hillsboro Inlet to Cedar Keys.	Key West, Fla.
8th.....	Waters of Gulf Coast from Cedar Keys, Fla., to mouth of Rio Grande, Tex., and Mississippi River below New Orleans.	Customhouse, New Orleans, La.
9th.....	Waters of Porto Rico and adjacent United States islands.	San Juan, P. R.
10th.....	United States waters of St. Lawrence River and Lakes Ontario and Erie.	Federal Building, Buffalo, N. Y.
11th.....	United States waters of Lakes St. Clair, Huron, and Superior, and Detroit River.	Post Office Building, Detroit, Mich.
12th.....	Waters of Lake Michigan and Green Bay.....	Federal Building, Milwaukee, Wis.
13th.....	Mississippi River above the mouth of the Missouri River, Minnesota, Illinois, Osage, Gasconade, and Missouri Rivers.	Federal Building, Rock Island, Ill.
14th.....	Ohio, Tennessee, Kanawha, and Monongahela Rivers.	Customhouse, Cincinnati, Ohio.
15th.....	Mississippi River below the Missouri River to New Orleans, La., and Red River.	Customhouse, St. Louis, Mo.
16th.....	Waters of Alaska.....	Ketchikan, Alaska.
17th.....	Waters of Washington and Oregon.....	Customhouse, Portland, Oreg.
18th.....	Waters of California.....	Customhouse, San Francisco, Cal.
19th.....	Waters of Hawaiian, Midway, Guam, and American Samoa Islands.	McCandless Building, Honolulu, Hawaii.

LIGHTHOUSE DEPOTS MAINTAINED ON JUNE 30, 1918.

[The principal depot of the district is indicated by the larger type.]

District.	Location.	District.	Location.
1st.....	Bear Island, Me.	8th.....	Fort San Jacinto, Galveston, Tex.
2d.....	LITTLE DIAMOND ISLAND, ME.	Mobile, Ala.	
3d.....	LOVELLS ISLAND, BOSTON, MASS.	PORT EADS, LA.	
	Woods Hole, Mass.	9th.....	SAN JUAN, P. R.
3d.....	Goat Island, R. I.	10th.....	BUFFALO, N. Y.
	Juniper Island, Vt.		Erie, Pa.
	New London, Conn.		Maumee Bay, Ohio.
	TOMPKINSVILLE, STATEN ISLAND, N. Y.		Rock Island, N. Y.
4th.....	Tucker Beach, N. J.		Sandusky Bay (Cedar Point), Ohio.
	EDGEWOOD, DEL.	11th.....	DETROIT, MICH.
	Lewes, Del.		Minnesota Point, Minn.
5th.....	Annapolis, Md.		St. Marys River, Mich.
	Lazaretto Point, Md.	12th.....	Charlevoix, Mich.
	Point Lookout, Md.		MILWAUKEE, WIS.
	PORTSMOUTH, VA.	16th.....	KETCHIKAN, ALASKA.
	Washington Wharf, D. C.	17th.....	Ediz Hook, Wash.
6th.....	Washington, N. C.		TONGUE POINT, OREG.
	CHARLESTON, S. C.	18th.....	GOAT ISLAND, CAL.
7th.....	Egmont Key, Fla.	19th.....	HONOLULU, HAWAII.
	KEY WEST, FLA.		

EXPLANATION OF TABLE ON PAGE 587.

The table of aids to navigation includes all those maintained by the Lighthouse Service, a total of 15,673. On page 593 are given facts regarding the private aids to navigation, 777 in number, maintained under authority. In the statistics relief light vessels are not counted and duplicate or auxiliary lights and fog signals are not counted, but double lights are counted separately when maintained on distinct structures or for distinct purposes. Buoys for the purpose of marking the positions of light vessels or larger buoys are not counted. Fog signals at light stations or on vessels are counted as separate aids, but not those attached to buoys, except in the case of submarine bells, which are counted as separate signals, whether on vessels or on buoys. Otherwise each buoy is counted only once, and if it is included in a higher class it is not in the lower class. Light-vessel lights are not counted separately.

AIDS TO NAVIGATION MAINTAINED BY THE UNITED STATES LIGHTHOUSE SERVICE JUNE 30, 1918.

[See note on p. 586.]

Class.	1st dist.	2d dist.	3d dist.	4th dist.	5th dist.	6th dist.	7th dist.	8th dist.	9th dist.	10th dist.	11th dist.	12th dist.	13th dist.	14th dist.	15th dist.	16th dist.	17th dist.	18th dist.	19th dist.	Total.
*LIGHTED AIDS.																				
Hyper-radiant lights.....																				
First-order lights.....	2	5	5	2	8	8	6	3									9	9	1	1
Second-order lights.....	7	3	3	3	2	2	1	2	1									1	2	57
Third-order lights.....	6	1	1	3	3	3	4	8	5	4	10	9				5	2	4	1	26
Three-and-one-half-order lights.....						1	1	3	2	3	6	1							1	68
Fourth-order lights.....	35	25	58	10	49	2	4	12	5	21	46	38				4	18	20	8	24
Fifth-order lights.....	18	15	18	4	22	3	1	13	3	9	16	13							2	335
Sixth-order lights.....	1	5	22	2	8	1			5	10	4	16						2	2	139
Range-lens lights.....			9	13	4	9				5	6	3					2			73
Reflector lights.....			1	12	16	31	13	7	2	6	27	4								46
Lens-lantern lights.....	2	7	1	12	16	31	13	7	2	6	27	4								130
Minor lights.....	11	26	58	19	44	64	39	157	14	38	91	47				94	25	37	37	801
Light-vessel lights.....	3	18	170	29	301	175	69	110	5		82	7				567	51	268	19	3,046
Electric lights without lens.....	1																			11
Gas-lighted buoys.....	6	45	52	12	59	4	5	28	5	32	77	17				5	11	9	6	52
Gas and whistling buoys.....	7	5	11	10	8	5	9	1			1	1				1	6	8		376
Gas and aerial bell buoys.....				6	19	6	6	2		2	11	18							5	72
Floating lights.....									1	22	5	5				6				410
Total.....	100	178	438	115	549	323	153	356	49	153	386	184				707	168	357	118	5,545
Lights on fixed aids.....	86	107	347	97	453	293	137	317	42	97	288	137				155	332	94		4,779
Lights on floating aids.....	14	71	91	18	96	25	16	39	7	56	98	47				13	25	24	7	766
Total lighted aids.....	100	178	438	115	549	323	153	356	49	153	386	184				707	168	357	118	5,545
UNLIGHTED AIDS.																				
Fog signals, engine power.....	19	21	37	5	15	4		3		9	38	47				10	23	30		261
Fog signals, clock power.....	37	13	59	6	66	3	1	14		5	5	9					3	6		228
Fog signals, hand power.....	12	1	2							1	1	1								17
Fog signals, electric.....		5	4	1	4					1	7						4			30
Submarine signals.....	2	8	9		8	5		3			5	4				1	4	2		61
Buoys, whistling (unlighted).....	19	11	8		2	6	3	5	1								7	18	1	81
Buoys, bell (unlighted).....	53	37	153	5	26	7		15	4	1	1	30				3	7	16		243
Buoys, iron.....	147	67	153	101	265	293	214	168	136	14	26	30				154	134	52	60	2,014
Buoys, spar (wood).....	704	595	885	101	938	6		178	154	154	489	135				41	132	31	8	4,882
Daymarks, beacons, etc.....	177	82	37	1	372	540	225	247	6		3	8				61	79	27		2,321
Total unlighted aids.....	1,170	840	1,252	208	1,966	864	449	633	147	184	575	237				271	363	186		128,10,128
Grand total.....	1,270	1,018	1,690	323	2,245	1,187	602	989	196	337	961	421				439	760	304		189,15,673

DETAILS AS TO CHARACTERISTICS OF LIGHTS (NOT INCLUDING LIGHT VESSELS).^a

	1st dist.	2d dist.	3d dist.	4th dist.	5th dist.	6th dist.	7th dist.	8th dist.	9th dist.	10th dist.	11th dist.	12th dist.	13th dist.	14th dist.	15th dist.	16th dist.	17th dist.	18th dist.	19th dist.	Total.
Fixed white:																				
Sixth order and above.....	31	30	52	17	59	25	4	27	6	22	30	22	2					2	4	337
Lights below the sixth order.....	1	10	83	9	228	136	53	140	4	5	65	6	39	19				16	13	1,007
Lighted buoys.....			5					2		10	2	5	1					2		27
Fixed red:																				
Sixth order and above.....	14	11	22	2	22	14	9	8	4	14	35	27			2					139
Lights below the sixth order.....	5	13	118	9	92	79	34	111	7	15	62	18	5	81	31				5	635
Lighted buoys.....		1	6					1	1	12	3		5							30
Flashing or occulting:																				
Sixth order and above.....	16	16	40	30	24	19	15	10	10	24	38	20	7	24	34				9	336
Lights below the sixth order.....	7	21	27	30	25	22	21	16	8	15	48	30	102	19	11				20	422
Lighted buoys.....	13	59	70	18	88	21	16	36	6	34	88	36	7	22	20				7	541
Fixed and flashing, sixth order and above.....	12	6	5		3	3	1	3	3	2	10	14		3						65
Candlepower:																				
50,000 to 190,000.....	5	4	4	5	4	7	5	5	3	4	7	1	1	2	9				1	67
200,000 to 490,000.....		1	2	2	1	1	1	1			3	1	1	1	2				1	18
500,000 and over.....		1	1																1	3
Twin light stations.....	2	3																		5
Stations with resident keepers.....	70	51	112	33	89	24	12	49	17	35	77	70	11	34	39				15	726

DETAILS AS TO ILLUMINANTS OF LIGHTS (NOT INCLUDING LIGHT VESSELS).^a

	1st dist.	2d dist.	3d dist.	4th dist.	5th dist.	6th dist.	7th dist.	8th dist.	9th dist.	10th dist.	11th dist.	12th dist.	13th dist.	14th dist.	15th dist.	16th dist.	17th dist.	18th dist.	19th dist.	Total.
Incandescent oil vapor.....	30	26	39	19	18	15	11	13	12	8	38	29	2	27	29				6	322
Oil (wick lamps):																				
Sixth order and above.....	41	33	78	9	75	34	12	29	10	34	45	43	4	2	2				8	459
Lights below the sixth order.....	6	15	188	16	304	215	87	224	8	20	101	21	44	267	42				15	1,573
Lighted buoys.....									1	22	5	5	6							36
Acetylene:																				
Sixth order and above.....	1	1	1	13	7	12	4	6	1	11	10	6	3	2	1				1	80
Lights below the sixth order.....	7	21	37	27	25	22	21	43	5	15	25	30	101	13	9				21	422
Lighted buoys.....	6	28	33	5	39	21	13	9		24	7	7	17		9				7	235
Oil gas:																				
Lights with mantles.....											52									52
Lights without mantles.....					13				1		1	1								16
Lighted buoys with mantles.....	1		13	3	35			2	2	34	64	27		5	7					193
Lighted buoys without mantles.....	6	32	35	10	14		3	28	4			2			6					140
Electric arc:																				
Sixth order and above.....																				
Lights below the sixth order.....																				
Electric incandescent:																				
Sixth order and above.....	1	1	1	8	7		2			9	12	4		2	3					50
Lights below the sixth order.....		8	3	5	4				5		4	2	1	17	7				5	61
Gas (coal), sixth order and above.....		2										1								3

^a Does not include the thirteenth, fourteenth, and fifteenth lighthouse (river) districts, in which there are 1,736 lights on fixed aids and 119 lights on floating aids, all of which use kerosene and are fixed, excepting 4, which use acetylene and are flashing, and 1 which uses electricity.

DETAILS AS TO LIGHTS ON LIGHT VESSELS.

	1st dist.	2d dist.	3d dist.	5th dist.	6th dist.	8th dist.	11th dist.	12th dist.	17th dist.	18th dist.	Total
Characteristics as to lights:											
1 fixed white light.....		3	1		1		4	4			13
2 fixed white lights.....		1	3	1		1			2	1	9
1 fixed red light.....								1			1
2 fixed red lights.....		2									2
1 fixed white and 1 fixed red light.....		1		3	1				1		6
1 white flashing, or occulting, and 1 fixed red light.....			2								2
1 white light, flashing or occulting.....	1	3	4	3	1	1	1	1		1	16
1 red light, flashing or occulting.....		1									1
2 white lights, flashing or occulting.....				1	1						2
Illuminants:											
Incandescent oil vapor.....		1			1	1					3
Acetylene.....	1		2	3	2						11
Oil (wick).....		6	4	3	1	1	4	6	3	1	28
Oil (wick) and acetylene.....			1	1							2
Oil (wick) and oil gas with mantle.....			1								1
Electric arc.....			1								1
Electric incandescent.....		1	1	1			1	1		1	6
Illuminating apparatus:											
Fourth order.....		1			1	1		1			4
Fifth order.....				1							1
Reflector.....		2	3	2	1		2		1		11
Reflector and lens lantern.....		2	2								2
Lens lantern.....	1	8	5	5	2	1	3	6	2	2	34

DETAILS AS TO FOG SIGNALS.

Kind and how operated.	1st dist.	2d dist.	3d dist.	4th dist.	5th dist.	6th dist.	7th dist.	8th dist.	10th dist.	11th dist.	12th dist.	16th dist.	17th dist.	18th dist.	Total
Steam:															
Whistle.....	8	5	6		5	2		1	3	30	31		3	6	100
Siren.....		1	1										1	1	4
Air:															
Whistle.....	1	4			1						5				12
Siren.....	2	3	23	1	5	1		1	3	7	10	5	6	16	83
Diaphone.....		1				1			3	1	1	1	2	6	16
Siren (electric).....				1					1	4				1	11
Reed horn.....	8	6	7	4	5			1				4	13		48
Submarine bells:															
On light vessels, driven by compressed air.....	1	7	7		7	3		2		3	4		3	2	30
On bottom, electric power.....										2					2
On buoys, operated by sea.....	1	1	2		1	2		1				1	1		10
Bell:															
Clockwork.....	37	13	59	6	66	3	1	14	5	5	9	1	3	6	228
Electric.....		5	4		3					3			1		16
Engine.....		1													1
Hand.....	12	1	2												15
Horn: Hand.....										1	1				2
Total.....	70	48	111	12	93	12	1	26	15	56	61	12	34	42	587

* Auxiliary fog signals (71), whistling buoys (153), and bell buoys (353) are not included.

LIGHTS ESTABLISHED DURING THE FISCAL YEAR 1918.

[204 lights.]

District.	Location.	Order.
2d.....	Canal Channel, Buzzards Bay, Mass. (4 lights).....	Lens lantern (2 acetylene, 2 electric incandescent).
3d.....	Sag Harbor, N. Y.	Minor.
4th.....	Block Island, Delaware River, N. J.	Minor (acetylene).
5th.....	Elizabeth River, Southern Branch, Va. (10 lights).....	Minor (5).
	Jones Point Shoal, Rappahannock River, Va.	Lens lantern (5 electric incandescent).
	T. D. Purnell Wreck, Rappahannock River, Va.	Minor.
6th.....	Arlington Cut, St. Johns River, Fla. (2 lights).....	Do.
	Fort Fremont, Beaufort River, S. C.	Lens lantern.
	Mill Point Cut, St. Johns River, Fla. (3 lights).....	Minor.
	Tiger Island Range Front Auxiliary, Cumberland Sound, Fla.	Do.
	White Shells Cut, St. Johns River, Fla. (2 lights).....	Do.
7th.....	Caximbas Pass, Fla.	Do.
	Miami Harbor, Fla. (17 lights).....	Minor (acetylene).
		Minor (15).
		Minor (1 acetylene).
		Reflector.
8th.....	Cypress Range, Mississippi River, La. (2 lights).....	Minor.
	East River, Escambia Bay, Fla.	Do.
	Head of Passes, Mississippi River, La. (2 lights).....	Do.
	Pass Christian, Miss. (3 lights).....	Do.
	Spanish River, Mobile River, Ala.	Do.
9th.....	Twelve Mile Island, Mobile River, Ala.	Do.
	Buck Island, Virgin Islands.	6th (acetylene).
	Port Louis, Augusta, St. Croix, Virgin Islands.	Minor.
	Frederiksted Harbor, St. Croix, Virgin Islands (2 lights).....	Do.
	Hams Bluff, St. Croix, Virgin Islands.	4th (incandescent oil vapor).
	Judre Bergs Hill, St. Thomas, Virgin Islands (2 lights).....	Reflector.
	Myhlenfeldt Point, St. Thomas, Virgin Islands.	5th.
	Navassa Island, Caribbean Sea.	4th (incandescent oil vapor).
10th.....	Black Rock Channel, Buffalo Harbor, N. Y. (12 float lights).....	Minor.
	Conneaut West Pierhead, Ohio.	Lens lantern.
11th.....	Blake Point, Lake Superior, Mich.	Lens lantern (acetylene).
	Ecorse Channel, Detroit River, Mich. (3 float lights).....	Minor.
	Fighting Island, Detroit River, Mich.	Lens lantern (acetylene).
	Mud Island Shoal, Detroit River, Mich. (float light).....	Minor.
	Sand Hills, Keweenaw Point, Mich.	Do.
12th.....	Outer Breakwater, Chicago, Ill.	Minor (acetylene).
	Racine South Breakwater, Wis.	Lens lantern (acetylene).
13th.....	19 lights.	Minor.
	9 lighted spars.	Do.
	1 float light.	Do.
14th.....	1 light.	Do.
	1 float light.	Do.
15th.....	52 lights.	Do.
16th.....	Beluga River, Cook Inlet, Alaska.	Do.
	Black Rock, Revillagigedo Channel, Alaska.	Lens lantern (acetylene).
	Inner Point, Port Walter, Alaska.	Minor.
	Kalgin Island, Cook Inlet, Alaska.	Lens lantern (acetylene).
	Katalla Bay, Alaska.	Minor.
	Klawak Island, Prince of Wales Island, Alaska.	Do.
	Klawak Reef, Prince of Wales Island, Alaska.	Lens lantern (acetylene).
	Middle Ground, Wrangell Strait, Alaska.	Minor (acetylene).
	Point Crowley, Chatham Strait, Alaska.	Lens lantern (acetylene).
	Red Bluff Bay, Chatham Strait, Alaska.	Minor.
	Tonki Cape, Afognak Island, Alaska.	Lens lantern (acetylene).
17th.....	Apple Cove Point, Puget Sound, Wash.	Do.
	Blakely Rock, Puget Sound, Wash.	Minor.
	Cathlamet Channel, Columbia River (2 lights).....	Do.
	Coffee Island Passage, Columbia River (2 lights).....	Do.
	Dibblee Dike, Columbia River.	Do.
	Flavel, Columbia River.	Minor (electric incandescent).
	Henric Crossing, Columbia River (2 lights).....	Minor.
	Isthmus Slough, Coos Bay, Oreg.	Do.
	Jetty Sands, Columbia River.	Do.
	Marshfield Channel, Coos Bay, Oreg. (2 lights).....	Do.
	Pillar Rock Channel, Columbia River.	Do.
	Salmon Bay, Puget Sound, Wash. (4 lights).....	Minor (3).
	Westport Slough, Columbia River.	Lens lantern (acetylene).
	Willapa Bay, Wash.	Minor.
19th.....	Cape Hanalei, Maui Island, Hawaii.	Do.
	Honolulu Harbor, Oahu Island, Hawaii (2 lights).....	Lens lantern (acetylene).
		Lens lantern (electric incandescent).

NOTE.—Light stations in the Virgin Islands were transferred to jurisdiction of Lighthouse Service by Executive order of July 20, 1917.

LIGHTS WHERE ILLUMINATION WAS IMPROVED DURING THE FISCAL YEAR 1918.

FLASHING OR OCCULTING LIGHTS CHANGED FROM FIXED LIGHTS (13 LIGHTS).

District.	Location.	District.	Location.
2d.....	Great Round Shoal Light Vessel, No. 86, Nantucket Sound, Mass.	16th.....	Mary Island, Revillagigedo Channel, Alaska.
4th.....	Penn Manor, Delaware River, Pa.		Sentinel Island, Favorite Channel, Alaska.
	Rehoboth Canal Jetty, Rehoboth Bay, Del.		Southeast Five-Finger Islands, Stephens Passage, Alaska.
8th.....	Galveston Jetty, Galveston Entrance, Tex.	18th.....	Lime Point, San Francisco Harbor, Cal.
10th.....	Charlotte Harbor, N. Y.	19th.....	Alia Point, Hawaii Island, Hawaii.
11th.....	Alpena, Lake Huron, Mich.		Kauhola Point, Hawaii Island, Hawaii.
	Huron Bay, Lake Superior, Mich.		

INCANDESCENT OIL-VAPOR LIGHTS CHANGED FROM OIL-WICK LIGHTS (3 LIGHTS).

4th.....	Finns Point Range Rear, Delaware River, N. J.	19th.....	Kauhola, Hawaii Island, Hawaii.
8th.....	Galveston Jetty, Tex. (from acetylene).		

ACETYLENE OR OTHER LIGHTS CHANGED FROM OIL-WICK LIGHTS, ETC. (41 LIGHTS),

2d.....	Derby Wharf, Salem Harbor, Mass.	10th.....	Manhattan Range, Maumee Bay, Ohio (oil gas to electric incandescent, 2 lights).
	Great Round Shoal Light Vessel, No. 86, Nantucket Sound, Mass.		South Buffalo South Side, Buffalo Harbor, N. Y. (electric incandescent).
	Misham Ledge Gas and Bell Buoy, 3, Buzzards Bay, Mass. (from oil gas).	11th.....	Alpena, Lake Huron, Mich. (from electric incandescent).
	Nobska Point Gas Buoy, 18, Vineyard Sound, Mass. (from oil gas).		Fighting Island Channel, Detroit River, Mich. (3 gas buoys from oil gas).
	Pollock Rip Gas Buoy, 2 C, Nantucket Sound, Mass. (from oil gas).		Huron Bay, Lake Superior, Mich.
3d.....	Overfalls Light Vessel, No. 69, seacoast of Delaware (from electric incandescent).		Portage Lake Ship Canals East Breakwater, Mich. (from oil gas).
4th.....	Deepwater Range Point Front, Delaware River, N. J. (electric incandescent).	12th.....	Grand Haven Pierhead, Mich. (electric incandescent).
	Fort Mifflin Bar Cut Range Rear, Delaware River, N. J. (electric incandescent).		Muskegon Pierhead, Mich. (electric incandescent).
	Marcus Hook Range Rear, Delaware River, Del.		Sturgeon Bay Bridge, Green Bay, Wis. (electric incandescent).
	Mud Island Range Front, Delaware River, Pa. (electric incandescent).	16th.....	Mary Island, Revillagigedo Channel, Alaska.
	Penn Manor, Delaware River, Pa.		Sentinel Island, Favorite Channel, Alaska.
	Rehoboth Canal Jetty, Rehoboth Bay, Del.		Southeast Five-Finger Islands, Stephens Passage, Alaska.
	Riverton, N. J. (electric incandescent).	17th.....	Marrowsstone Point, Admiralty Inlet, Wash. (electric incandescent from acetylene).
5th.....	Torresdale, Pa. (electric incandescent).	18th.....	Lime Point, San Francisco Harbor, Cal.
	Pooles Island, Chesapeake Bay, Md. (3 lights).	19th.....	Alia Point, Hawaii Island, Hawaii.
	35-Foot Channel, Chesapeake Bay, Va. (4 gas buoys from oil gas).		
10th.....	Charlotte Harbor, N. Y. (electric incandescent, 2 lights).		

LIGHTS DISCONTINUED DURING THE FISCAL YEAR 1918.

[84 lights, including float lights.]

District.	Location.	Order.
4th.....	Biles Island, Delaware River, Pa.	Minor.
	Deadman Shoal, Delaware Bay, N. J.	Minor (acetylene).
5th.....	Tarpley Point Shoal, Rappahannock River, Va.	Minor.
6th.....	Oyster Beds Range, Savannah River, Ga. (2 lights).	Reflector.
	St. Johns River, Fla. (6 lights).	Minor (5).
8th.....	Head of Passes, Mississippi River, La. (2 lights).	Lens lantern (1).
	Mobile Channel, Ala.	Minor.
11th.....	West Neebish Channel, St. Marys River, Mich. (2 lights).	Lens lantern (acetylene).
12th.....	12 lights.	Lens lantern (oil gas).
	9 lighted spar buoys.	Minor.
	1 float light.	Do.
14th.....	4 lights.	Do.
15th.....	32 lights.	Do.

LIGHTS DISCONTINUED DURING THE FISCAL YEAR 1918—Continued.

District.	Location.	Order.
16th.....	Katalla Bay, Alaska.....	Minor.
17th.....	Elk Spit, Willapa Bay, Wash.....	Do.
	Porter, Coos Bay, Oreg.....	Do.
	Salmon Bay, Puget Sound, Wash. (2 lights).....	Do.
19th.....	Honolulu Channel, Oahu Island, Hawaii (4 lights).....	Lens lantern.
	Kanahena Point, Maui Island, Hawaii.....	Do.

GAS BUOYS ESTABLISHED AND DISCONTINUED DURING THE FISCAL YEAR 1918.

District.	Location.	District.	Location.
	ESTABLISHED (41).		
2d.....	Canal Channel, Buzzards Bay, Mass. Great Ledge, Woods Hole, Mass. Mosher Lodge (bell), Buzzards Bay, Mass. West Island Shoal, Buzzards Bay, Mass.	17th.....	Tongue Point Crossing, Columbia River.
3d.....	Coal Barge Wreck, seacoast, N. J. Coal Barge Wreck, Lower Bay, N. Y. Hampshire Wreck, seacoast, N. J. Henry Failing Wreck, seacoast, R. I. Mudscow V 5 Wreck, Lower Bay, N. Y. Wreck, Lower Bay, N. Y.	18th.....	New York Slough (bell), Suisun Bay, Cal.
4th.....	Orleans Wreck (bell), seacoast, Del.	19th.....	Waihee Reef, Kahului Harbor, Hawaii.
5th.....	Cherubim Wreck, Chesapeake Bay, Va. Derrick Wreck, James River, Va. Georgia Wreck, seacoast, Va. Haubage Wreck, seacoast, Va. James A. Garfield Wreck, Chesapeake Bay, Md. Newport News North Channel, Va. (2). North River Entrance (bell), Albemarle Sound, N. C. Thimble Shoal Dredged Channel, Va. (4 including 2 bell). Scow Wreck, Hampton Roads, Va. 35-Foot Channel, Chesapeake Bay, Va.		DISCONTINUED (28).
6th.....	Second Cut, Savannah River, Ga.	2d.....	Canal Channel, Buzzards Bay, Mass.
8th.....	Mobile Channel, Mobile Bay, Ala. Navy Yard Outer Bank, Pensacola, Fla. (bell).	3d.....	South Channel, Boston Harbor, Mass. Coal Barge Wreck, seacoast, N. J. Coal Barge Wreck, Lower Bay, N. Y. Hampshire Wreck, seacoast, N. J. Henry Failing Wreck, seacoast, R. I. Mudscow V 5 Wreck, Lower Bay, N. Y.
10th.....	Stony Island, Lake Ontario, N. Y. Strawberry Island Cut, Niagara River, N. Y.	4th.....	Bulkhead Shoal Channel, Delaware River, Del. (2).
11th.....	Fighting Island Channel, Detroit River, Mich. Pointe aux Barques (bell), Lake Huron, Mich. Watson Reefs, St. Marys River, Mich. West Neebish Channel (2), St. Marys River, Mich.	5th.....	James A. Garfield Wreck, Chesapeake Bay, Md. Powhatan Wreck, Hampton Roads, Va. (2, 1 a bell). 35-Foot Channel, Chesapeake Bay, Va.
12th.....	Waukegan Shoals, Lake Michigan, Ill.	9th.....	San Augustin Shoal, San Juan, P. R.
16th.....	Helm Rock (bell), Sumner Strait, Alaska.	10th.....	Point Peninsula, Lake Ontario, N. Y.
17th.....	Elk Spit, Willapa Bay, Wash.	11th.....	Bar Point Channel, Detroit River, Mich. Blake Point, Lake Superior, Mich. (bell). Eagle River Shoal, Lake Superior, Mich. (bell). Fighting Island Channel, Detroit River, Mich. Pointe aux Barques, Lake Huron, Mich. (whistle). Rains Island Shoal, St. Marys River, Mich. Vidal Shoals, St. Marys River, Canada. West Neebish Channel, St. Marys River, Mich.
		12th.....	North Bank, Indiana Harbor, Ill. Waukegan Shoals, Lake Michigan, Ill. (bell).
		16th.....	Helm Rock, Sumner Strait, Alaska (bell).
		17th.....	Tongue Point Crossing, Columbia River.

FOG SIGNALS IMPROVED AND DISCONTINUED DURING THE FISCAL YEAR 1918.

District.	Location.	Character.
	IMPROVED (4).	
2d.....	Wings Neck, Buzzards Bay, Mass.....	From— Bell operated by machinery. To— 1st-class reed horn.
17th.....	Marrowstone Point, Admiralty Inlet, Wash.	Acetylene gun, and bell operated by machinery. 3d-class reed horn.
18th.....	Oakland Harbor, Cal.....	Bell operated by machinery. Air diaphone.
	Southampton Shoal, San Francisco Bay, Cal.	Do. Do.
	DISCONTINUED (1).	
10th.....	Buffalo Light Vessel, No. 98, Lake Erie, N. Y.	1st-class air siren.

LIGHT VESSELS DISCONTINUED DURING THE FISCAL YEAR 1918.

District.	Number of vessel	Name of station.
10th.....	98	Buffalo Approach, N. Y.

PRIVATE AIDS TO NAVIGATION MAINTAINED ON JUNE 30, 1918.

(Under the act of June 20, 1906.)

District.	Lights.	Buoys.*		Other unlighted aids.	Fog signals.	Total.
		Lighted.	Unlighted.			
1st.....	1		32	3		36
2d.....	41		29	12		82
3d.....	29	3	93	7	2	134
4th.....			7			7
5th.....	115	9	125	60	3	212
6th.....			1			1
7th.....	4		9	2		15
8th.....	12		20	8		40
9th.....			2			2
10th.....	24	3	2	1	1	31
11th.....	13	13	54	1		81
12th.....	30	3	8		7	48
13th.....		1				1
15th.....	1					1
16th.....	2		1			3
17th.....	2		14		2	18
18th.....	23	2	6	1	10	42
19th.....	20		3			23
Total.....	217	34	406	95	25	777

BRIDGES OVER NAVIGABLE WATERS LIGHTED ON JUNE 30, 1918.

(Under the act of Aug. 7, 1882, 22 Stat., 309.)

District.	Lighted bridges.	District.	Lighted bridges.	District.	Lighted bridges.
1st.....	22	8th.....	261	15th.....	8
2d.....	63	9th.....	1	17th.....	55
3d.....	195	10th.....	58	18th.....	29
4th.....	17	11th.....	53	Total.....	1,432
5th.....	155	12th.....	167		
6th.....	58	13th.....	80		
7th.....	24	14th.....	186		

AIDS MAINTAINED UNDER CONTRACT DURING FISCAL YEAR 1918.

District.	Name of aids.	Annual cost.
1st.....	Kennebunkport Pier Light, Me.....	\$150.00
7th.....	Caximbas Pass and Big Marco Pass, Fla. (4 buoys).....	72.00
9th.....	Christianssted Harbor, St. Croix, V. I. (10 buoys).....	480.00
10th.....	Lake Ontario and the St. Lawrence River, N. Y. (41 buoys).....	2,500.00
	Niagara River and Black Rock Channel, N. Y. (75 buoys).....	984.50
11th.....	Superior Bay, St. Louis Bay and River, Wis. and Minn. (32 lights).....	1,980.00
12th.....	Fox River, Wis. (14 spar buoys); Green Bay, Wis. (18 spar and 2 gas buoys).....	200.00
16th.....	St. Michael Canal and Apoon Pass, Alaska (32 buoys), and Orizaba Reef Bell Buoy.....	428.50
18th.....	Norton Sound (11 lights).....	680.00
	Hookton Channel Range Rear Light, Cal.....	1.00

LIGHT VESSELS IN COMMISSION DURING THE FISCAL YEAR, 1918.

Number.	Station.	District.	Tonnage.		When built.	Material of hull.	Dimensions.			Regular complement.		Fog signal.	Illuminant.	Cost of repairs made during fiscal year.	Cost of maintenance during fiscal year.	Original cost.	On station.	
			Gross.	Net.			Length over all.	Breadth.	Depth.	Officers.	Crew.						Months.	Days.
74	Portland, Me.	1	495		1902	Wood	129 9	25 6	13 0	4	8	12" steam whistle b.	Acet.	\$2,411	\$1,356	\$88,806	12	....
75	Handkerchief, Mass.	2	140		1882	do.	89 4	23 0	10 0	5	5	Bell	do.	922	6,477	12,000	10	14
76	Relief	2	104		1884	do.	87 0	20 0	10 0	1	1	Bell or horn.	Oil.	723	2,427		4	26
77	Stone Horse Shoal, Mass.	2	185		1884	do.	81 6	21 6	10 0	7	7	8" air whistle.	do.	799	3,500		12	....
78	Cross Rip, Mass.	2	104		1887	do.	81 6	21 6	10 0	5	5	Bell.	Acet.	4,141	2,700	25,040	1	9
79	Bridge Light, Mass.	2	104		1887	do.	81 6	21 6	10 0	5	5	8" air whistle.	Oil.	49	3	13,883	1	27
80	Vineyard Sound, Mass.	2	387		1876	do.	120 2	28 2	11 6	3	3	First-class air siren b.	do.	314	473	33,000	12	....
81	Hon and Chatham, Mass.	2	470		1876	do.	120 2	28 2	11 6	3	3	12" steam whistle.	do.	32	10	61,000	11	18
82	Beaumont, Mass.	2	470		1891	Comp.	120 7	28 6	11 6	4	4	12" steam whistle.	do.	37	10	61,000	11	24
83	Relief, Mass.	2	310		1882	Steel	118 10	28 0	11 0	7	7	First-class air siren b.	do.	37	10	61,000	11	24
84	Relief, Mass.	2	580		1884	Comp.	122 0	28 0	13 0	4	4	12" steam whistle.	do.	4,500	12,583	67,282	4	10
85	Pollack Rip, Mass.	2	538		1901	Steel	123 9	28 0	13 0	6	6	do.	Acet.	4,500	12,583	67,282	4	10
86	Relief, Mass.	2	683	246	1907	do.	135 5	28 0	13 0	8	8	do.	Oil.	644	13,503	99,000	11	28
87	Nantuxet Shoals, Mass.	2	683	246	1907	do.	135 5	28 0	13 0	8	8	do.	Oil.	644	13,503	99,000	11	28
88	Great Round Shoal, Mass.	2	685	225	1908	do.	135 5	28 0	13 0	4	4	do.	do.	2,798	10,707	107,213	3	17
89	Relief.	2	320		1883	Wood	104 0	24 8	11 6	2	5	Bell.	Oil and oil gas.	2,289	6,979	13,462	10	6
90	Scotland, N. J.	3	155		1854	do.	79 8	21 8	10 4	4	1	do.	Oil.	7,173	7,798	12,000	6	13
91	Bartlett Reef, Conn.	3	250		1854	do.	103 6	22 6	11 0	4	1	First-class air siren, 6" whistle.	do.	1,625	1,884	28,064	10	11
92	Relief.	3	186		1857	do.	94 2	24 0	9 0	5	5	10" air.	do.	250	682	7,500	11	5
93	Ram Island Reef, Conn.	3	387		1875	do.	115 6	24 0	13 0	4	4	Wh. b.	do.	23,726	11,078	42,200	5	13
94	Brenton Reef, R. I.	3	197		1882	Iron.	119 6	25 0	10 6	6	6	First-class steam siren b.	Acet.	23,726	11,078	50,000	10	28
95	Northeast End, N. J.	3	470		1891	Comp.	120 10	27 8	12 0	4	7	do.	Acet.	1,248	10,907	52,780	8	17
96	Cornfield Point, Conn.	3	283		1892	Iron.	118 10	26 9	11 0	2	4	12" steam whistle b.	Acet.	6,900	5,990	53,325	4	21
97	Relief.	3	590	204	1897	Comp.	122 10	28 6	12 6	350	2	12" steam whistle b.	Fl. line.	6,907	44,493	74,750	4	26
98	Five Island, N. Y.	3	690	204	1897	do.	122 10	28 6	12 6	350	2	do.	do.	4,206	15,173	79,500	8	23
99	Overfalls, Del.	3	668	188	1904	Steel	129 0	28 6	12 6	325	2	do.	Oil or acet.	1,971	8,512	89,080	6	29
100	Relief.	3	668	188	1904	do.	129 0	28 6	12 6	325	2	12" steam whistle b.	do.	2,028	13,056	89,000	11	6
101	Five-Fathom Bank, N. J.	3	668	246	1907	do.	135 5	29 0	13 0	4	10	12" steam whistle b.	Oil.	2,519	16,896	99,000	11	1
102	Ambrose Channel, N. Y.	3	668	246	1907	do.	135 5	29 0	13 0	4	10	12" steam whistle b.	E. arc.	2,519	16,896	99,000	11	1
103	Relief.	3	210		1849	Wood	98 0	25 0	9 0	1	5	Bell.	Oil.	197	1,545	12,402	1	13

45	Thirty-Five Foot Channel, Va.	5	4401	285	1887	Steel	124	6	27	6	13	0	(d)	2	6	8" air whistle b.	do.	133	6,996	58,500	14	23
46	Tail of the Horseshoe, Va.	5	4401	1887	Comp.	do.	124	6	27	6	12	0	(d)	4	6	12" steam whistle b.	do.	4,976	10,915	60,000	11	0
49	Relief.	5	4470	1890	Comp.	do.	124	10	27	0	14	0	(d)	4	6	First-class air siren b.	Acet.	103	7,713	57,900	10	0
52	Fenwick Island Shoal, Del.	5	4416	1892	Iron	do.	118	10	26	6	12	0	350	5	10	do.	do.	2,444	13,756	62,000	12	22
71	Diamond Shoal, N. C.	5	4590	204	Comp.	do.	122	10	28	6	13	0	350	5	10	12" steam whistle w. b.	El. inc.	2,392	15,961	70,700	10	10
72	Relief.	5	4983	1900	Steel	do.	123	6	28	6	14	0	350	5	10	do.	do.	3,366	17,418	89,000	10	3
80	Cape Lookout Shoals, N. C.	5	4988	188	do.	do.	129	6	28	6	12	0	350	5	10	do.	do.	5,413	14,879	85,000	3	3
91	Winter-Quarter Shoal, N. C.	5	4985	225	1908	do.	135	5	29	0	13	0	400	4	10	do.	do.	122	16,644	107,213	11	24
97	Bush Bluff, Va.	5	87	1876	Comp.	do.	80	6	19	5	12	0	(/)	1	2	do.	do.	199	2,964	107,213	11	24
101	Cape Charles, Va.	5	4360	1916	Steel	do.	101	10	25	0	13	2	200	4	7	First-class air siren b.	Oil gas.	1,653	11,762	108,507	8	28
1	Martins Industry, S. C.	6	275	1855	Wood	do.	108	0	24	0	13	0	(d)	2	8	do.	do.	398	9,949	48,000	10	17
34	Charleston, S. C.	6	150	1864	do.	do.	101	10	23	0	10	0	(d)	2	8	Air diaphone.	Acet.	1,973	8,478	61,338	9	5
53	Relief.	6	310	1892	Iron	do.	119	0	26	6	11	0	325	3	10	12" steam whistle b.	do.	2,703	23,441	99,000	5	21
84	Brunswick, Ga.	6	403	1907	Steel	do.	135	5	29	0	13	0	325	4	10	do.	do.	3,714	10,925	104,004	10	13
94	Frying Pan Shoals, N. C.	6	4070	229	1911	do.	135	6	29	0	13	0	363	4	10	12" steam whistle b.	Inc. o. v.	162	14,028	104,004	10	13
43	Relief.	8	191	1881	Comp.	do.	118	0	25	0	12	0	(d)	2	8	do.	do.	6	1,007	50,000	8	18
81	Head Bank, Tex.	8	4668	188	1904	Steel	129	0	28	6	12	6	325	4	8	First-class air siren b.	Inc. o. v.	3,995	13,511	90,000	8	18
102	Southwest Pass, La.	8	4360	1916	do.	do.	101	10	25	0	13	2	200	4	7	do.	do.	2,062	12,963	110,065	9	5
61	Lake Huron, Mich.	11	105	1883	Wood	do.	87	2	21	6	8	0	(d)	3	3	do.	do.	2,892	5,945	14,068	7	16
62	Bar Point Shoal, Mich.	11	105	1883	do.	do.	87	2	21	6	8	0	(d)	3	3	do.	do.	1,235	5,872	14,068	7	8
75	Lake St. Clair, Mich.	11	160	1912	Steel	do.	83	9	34	0	4	9	(d)	2	2	do.	do.	1,737	3,960	14,968	7	8
82	Relief.	11	2909	61	1912	do.	96	2	21	0	8	11	40	4	3	10" steam whistle b.	Acet.	1,442	8,450	42,910	2	27
89	Martin Reef, Mich.	11	2935	76	1908	do.	88	3	21	0	10	0	40	4	3	6" steam whistle b.	Oil.	325	7,766	37,500	7	3
96	Poe Reef, Mich.	11	2170	1914	do.	do.	101	0	23	6	11	5	(/)	3	4	First-class air siren b.	El. inc.	182	7,017	71,262	7	3
55	Lansing Shoal, Mich.	12	129	1891	Wood	do.	102	8	20	0	9	0	100	4	2	8" steam whistle b.	Oil.	1,588	7,344	13,600	7	10
56	North Manitowish Shoal, Mich.	12	130	1891	do.	do.	102	8	20	0	8	10	100	4	2	do.	do.	368	7,071	13,600	7	19
57	Grays Reef, Mich.	12	130	1891	do.	do.	102	8	20	0	8	10	100	4	2	do.	do.	416	7,238	13,600	7	14
60	French Shoal, Mich.	12	165	1893	do.	do.	57	2	21	6	8	6	(d)	3	3	10" steam whistle b.	do.	1,144	5,925	13,940	7	11
77	Peshigo Reef, Wis.	12	2135	1896	Steel	do.	75	0	21	6	4	0	(d)	2	3	8" air whistle.	do.	416	5,969	13,940	7	11
95	Milwaukee, Wis.	12	2585	156	1912	do.	108	5	23	0	10	2	200	4	2	First-class air siren b.	El. inc.	299	12,091	74,558	10	3
98	Relief.	12	2165	1915	do.	do.	101	0	23	6	11	5	100	4	2	First-class air siren b.	do.	1,164	7,704	87,025	5	37
67	Umatilla Reef, Wash.	17	483	1897	Comp.	do.	122	7	28	6	13	0	200	4	11	12" steam whistle b.	Oil.	5,684	19,972	66,750	9	13
88	Columbia River, Ore.	17	483	206	1907	Steel	135	5	29	0	13	0	325	4	11	do.	do.	2,531	14,894	90,000	8	14
92	Relief.	17	4885	225	1906	do.	135	5	29	0	13	0	400	2	5	do.	do.	3,040	17,213	107,213	8	24
93	Swiftnure Bank, Wash.	17	4885	225	1906	do.	135	5	29	0	13	0	400	4	11	do.	do.	767	18,420	107,213	9	24
70	San Francisco, Cal.	18	4590	1897	Comp.	do.	122	10	28	6	13	0	349	4	11	do.	do.	2,347	19,479	79,000	10	20
76	Relief.	18	4578	169	1904	Steel	129	6	28	6	12	0	390	2	5	do.	do.	5,922	17,235	90,000	10	17
83	Blunt's Reef, Cal.	18	4668	188	1904	do.	129	0	28	6	13	0	390	4	11	do.	do.	3,290	16,321	90,000	10	17

a Displacement (salt water).
 b Submarine signal.
 c Length between perpendiculars.

d Sail.
 e Wood sheathed.
 f No means of propulsion.

g Displacement (fresh water).
 h Sunk Aug. 4, 1918, by an enemy submarine.
 i Replaced light vessel No. 6 which was lost February 4, 1918.

k Partially destroyed by fire on March 3, 1918.
 l Condemned by board of survey July 10, 1918.

TENDERS OF LIGHTHOUSE SERVICE IN COMMISSION DURING THE FISCAL YEAR 1918.

Name.	District.	Displacement.		When built.	Description.	Material of hull.	Dimensions.			Mean draft.		Indicated horsepower.	Regular complement.		Miles steamed.	Coal consumed for all purposes.	Cost of repairs.	Cost of maintenance.	Original cost.
		Light.	Loaded.				Length over all.	Breadth.	Depth.	Light.	Loaded.		Officers.	Crew.					
Hibiscus.....	1	Tons. 818	Tons. 1,081	1908	Steamer, twin screw...	Steel...	Fed. 190	Fed. 30	Fed. 16	Ft. in. 11	Ft. in. 13	1,000	6	26	12,803	1,987	\$8,679	\$42,895	\$184,643
Zizania.....	1	575	643	1888	.....do.	Iron...	161	27	12	8	9	650	5	22	12,650	1,089	2,088	34,330	48,739
Anemone.....	2	818	1,033	1908	.....do.	Steel...	190	30	16	11	0	1,000	6	26	14,175	1,934	1,899	47,033	191,999
Azalea.....	2	330	516	1891	Steamer, single screw...	do.	154	25	12	6	9	400	5	22	11,579	988	6,235	31,832	76,792
Mayflower.....	2	630	668	1887	Steamer, twin screw...	do.	164	30	12	7	9	650	5	24	10,436	1,421	2,326	36,510	74,872
Daisy.....	3	61	84	1892	Steamer, single screw...	Wood...	80	14	5	4	0	60	2	5	6,210	137	2,104	8,399	6,500
Gardena C.....	3	217	245	1879	.....do.	do.	417	20	9	6	6	200	4	11	6,648	702	2,820	26,086	99,987
John Rodgers.....	3	455	571	1883	Steamer, side wheel...	Iron...	160	27	9	6	7	260	4	17	6,648	2,162	3,877	43,392	122,259
Larkspur.....	3	738	888	1903	Steamer, twin screw...	Steel...	169	30	14	9	1	750	6	24	12,644	2,162	3,877	43,392	122,259
Mistletoe.....	3	455	476	1878	Steamer, side wheel...	Wood...	160	26	9	6	9	370	4	16	7,079	654	939	25,954	45,833
Pansy.....	3	431	454	1878	Steamer, twin screw...	Iron...	132	25	11	7	7	250	4	18	5,298	694	8,906	26,599	48,739
Trump.....	3	774	1,142	1908	.....do.	Steel...	190	30	16	10	7	1,000	6	26	19,783	2,165	6,967	44,465	191,638
Myrtle.....	3	435	542	1872	Steamer, single screw...	Wood...	140	25	11	9	6	225	4	16	18,304	1,054	2,516	26,491	44,500
Iris.....	4	519	606	1897	.....do.	Steel...	153	30	10	8	7	800	5	20	11,067	1,368	67	30,999	84,407
Woodbine.....	4	85	107	1913	Gasoline, single screw...	Wood...	96	16	7	5	2	125	2	3	5,280	10,563	137	11,266	24,728
Columbine.....	5	429	643	1892	Steamer, single screw...	Steel...	155	27	15	9	6	800	6	19	17,187	1,159	8,966	31,908	58,238
Arbutus.....	5	398	545	1879	Steamer, twin screw...	Wood...	153	25	11	7	1	360	6	22	7,781	834	1,766	35,518	46,799
Holly.....	5	431	499	1881	Steamer, side wheel...	Comp.	176	24	10	7	0	400	5	18	6,074	657	11,463	27,310	41,911
Yessamine.....	5	269	403	1881	.....do.	do.	156	24	10	7	3	350	4	18	5,092	569	5,475	25,083	41,911
Juniper.....	5	125	146	1903	Steamer, twin screw...	Iron...	98	18	8	4	6	240	2	9	6,586	422	7,244	14,707	29,425
Laurel.....	5	218	299	1915	Steamer, single screw...	Wood...	105	23	9	6	1	290	4	12	11,196	463	1,246	19,566	55,502
Maple.....	5	567	799	1898	Steamer, twin screw...	Wood...	164	30	12	7	3	650	6	24	12,504	1,601	3,201	41,849	93,889
Orchid.....	5	818	1,081	1908	.....do.	do.	190	30	16	11	0	1,000	6	27	13,019	1,854	8,798	42,705	186,151
Cypress.....	6	790	1,080	1908	.....do.	do.	190	30	16	10	9	1,000	7	27	19,268	2,583	3,788	49,459	191,633
Mangrove.....	6	605	831	1897	.....do.	do.	164	30	12	7	6	550	5	24	11,568	2,262	17,001	41,437	74,988

Palmetto.....	6	156	170	1917	Gasoline, twin screw...	do...	90	22	8	3	8	4	0	150	4	8	5,785	{ ^{c12} 12,777 ^{e4} 3,700	{ ^{c12} 1,929 ^{e4} 276	17,554	27,687
Water Lily.....	6	29	39	1895	do...	Wood.	64	11	5	2	11	3	8	36	2	2	6,064	276	6,055	9,261	
Ivy.....	7	736	916	1904	Steamer, twin screw...	Steel.	173	30	13	8	5	9	6	700	5	24	10,202	2,383	56,169	123,860	
Snowdrop.....	7	30	41	1896	Gasoline, twin screw...	Wood.	90	11	5	2	10	3	7	32	2	2	2,055	1,548	5,473	9,700	
Camellia.....	8	276	377	1911	Steamer, twin screw...	Steel.	117	24	10	5	10	7	7	280	4	17	4,964	684	27,265	57,412	
Magnolia.....	8	685	877	1904	do...	do...	173	30	13	7	6	9	2	700	5	24	9,850	1,534	41,012	124,874	
Sunflower.....	8	806	1,246	1907	do...	do...	174	31	15	10	5	14	6	900	6	26	14,000	2,039	24,289	124,938	
Lilac.....	9	542	582	1892	Steamer, single screw...	do...	155	27	15	11	0	11	6	800	5	19	10,004	946	2,335	42,463	92,125
Crocus.....	10	681	1,035	1904	Steamer, twin screw...	do...	165	29	14	9	6	12	3	700	5	22	6,541	1,255	72,496	38,330	119,718
Amaranth.....	11	597	7975	1892	Steamer, single screw...	do...	166	28	14	8	6	12	6	672	5	20	10,086	1,297	2,631	35,067	74,994
Aspen.....	11	7333	7415	1906	do...	do...	128	25	12	7	3	8	3	440	4	10	9,975	569	1,707	18,027	70,573
Clover.....	11	1183	7205	1899	do...	Wood.	93	22	7	5	4	6	4	140	4	6	9,462	382	775	15,683	.....
Margold.....	11	477	7696	1890	do...	Iron.	180	27	12	8	5	11	0	550	5	20	10,859	1,059	24,545	34,499	84,871
Hyacinth.....	12	462	7914	1903	do...	Steel.	165	28	14	7	0	11	6	678	5	21	8,889	1,247	2,862	27,517	115,000
Sumac.....	12	600	7857	1903	Steamer, twin screw...	do...	169	30	13	8	10	11	9	700	5	23	7,638	1,556	8,292	42,137	114,992
Dandelion.....	13	222	302	1893	Steamer, stern wheel...	Wood.	140	31	5	2	6	3	3	500	4	15	8,589	1,273	4,597	24,415	22,174
Goldenrod	14	194	723	1898	do...	Steel.	169	27	4	2	5	3	4	152	.....	.....	.....	.....	1,830	7,964	33,221
Oleander.....	15	463	7548	1903	do...	do...	189	34	7	3	10	4	6	600	1	17	14,116	2,497	851	31,156	60,000
Fern.....	16	245	317	1915	Steamer, single screw...	Wood.	112	22	10	1	8	6	6	300	4	11	11,343	2,457	451	27,204	62,100
Cedar.....	16	1,245	1,970	1917	do...	Steel.	201	36	18	9	6	14	0	1,150	8	23	12,380	1,102	3,103	70,730	246,189
Heather.....	17	631	831	1903	do...	do...	179	28	15	9	6	11	6	685	7	19	7,651	780	65,084	35,015	118,568
Manzanita.....	17	774	1,000	1908	Steamer, twin screw...	do...	190	30	16	10	7	12	7	1,000	7	23	10,286	1,597	756	38,509	211,817
Rose.....	17	395	567	1916	do...	do...	127	24	11	7	0	9	4	330	4	16	8,234	13,576	3,429	3,186	92,135
Madrono.....	18	654	806	1885	Steamer, single screw...	Iron.	180	27	15	9	9	11	6	750	6	19	8,566	1,084	8,372	29,889	87,872
Sequoia.....	18	809	1,100	1908	Steamer, twin screw...	Steel.	190	30	16	10	11	13	8	1,000	7	23	11,660	1,317	26,024	36,024	213,499
Kukul.....	19	838	935	1908	do...	do...	190	30	16	11	2	12	0	1,000	7	23	12,112	1,945	17,670	60,763	213,880

^a Light—without cargo and deck loads, and a minimum supply of stores, provisions, water, and coal or oil.
^b Loaded—bunkers or fuel-oil tanks full of coal or oil, all tanks, including trimming tanks, full of water, full stores and provisions, and an average maximum cargo and deck load.

^c Transferred to Navy Department.

^d Length between perpendiculars.

^e Gallons gasoline.

^f Displacement (fresh water).

^g Operated by U. S. Engineer Department.

^h Barrels of fuel oil. 1 barrel=42 gallons.

CONSTRUCTION OF TENDERS AND LIGHT VESSELS.

Tender "Aster" and barge.—The act of July 1, 1916, appropriated \$20,000 for constructing or purchasing and equipping a small tender and barge for the eighth district, Texas and Louisiana. It was proposed to purchase a suitable vessel for a tender, and construct the barge from plans and specifications now in preparation. Bids were twice invited for the purchase of a suitable vessel, without satisfactory results owing to the scarcity of vessels caused by war conditions. It is proposed to invite bids again when conditions become more normal. Amount expended to June 30, 1918, \$13.14.

Power derrick barge.—The act of July 1, 1916, appropriated \$100,000 for aids to navigation, Hudson River, N. Y. It was found that in the construction of these aids a light-draft power barge with derrick was required. A suitable barge available for purchase could not be found, and accordingly plans and specifications were prepared for a wooden power derrick barge, and on January 13, 1917, a contract was awarded to Rice Bros., East Boothbay, Me., for the construction of the hull, in the sum of \$29,400. The keel, stem, sternpost, and frames were partly completed when, on July 10, 1917, a disastrous fire occurred at the plant of the above concern, destroying all but four frames, the keel, stem, and sternpost being uninjured.

New material was immediately procured and reconstruction commenced. The vessel was launched on June 5, 1918, and completed and delivered on July 23, 1918, ready for the installation of the propelling machinery and auxiliaries by the Government. Amount expended to June 30, 1918, \$1,277.79.

Tender "Oak."—The act of June 12, 1917, appropriated \$150,000 for a lighthouse tender for the third district to replace the tender *Gardenia* or for general service. Plans and specifications are in preparation, but no expenditures were made to June 30, 1917.

Specifications were prepared and bids invited for the construction of the vessel. The lowest bid received being greatly in excess of the appropriations, all were rejected. It is proposed to again invite bids when additional funds can be made available to meet the increased costs of production under the present abnormal conditions. Amount expended to June 30, 1918, \$7,237.

Light vessel "No. 99."—The act of August 24, 1912, appropriated \$130,000 for a light vessel for general service. Plans and specifications were prepared for a light vessel for the Great Lakes. Bids were received on May 25, 1916, and on June 29, 1916, a contract was awarded to Rice Bros., East Boothbay, Me., in the sum of \$61,000. Amount expended to June 30, 1917, \$28,329.42. The construction of the vessel had reached a degree of completion of approximately 53 per cent on June 30, 1917. On July 10, 1917, a disastrous fire occurred at the builders' plant in which the vessel and the greater part of its fittings were rendered a total loss.

The contractors took prompt steps to procure new material and the construction of a new vessel, a duplicate of the one destroyed, was commenced. On June 30, 1918, the work had reached a degree of completion of approximately 18 per cent. Amount expended to June 30, 1918, \$33,221.03.

Light vessel "No. 100."—Plans and specifications are in preparation for a large light vessel for station at Nantucket Shoals, Mass. There is a balance of approximately \$51,600 remaining under the appropriation of August 26, 1912, for light vessels, but the construction of this vessel from the available balance will not be possible until additional funds are available to meet the higher costs of production caused by the present abnormal conditions. No expenditures were made to June 30, 1918.

Light vessels "No. 103" and "No. 104."—The act of June 12, 1917, appropriated \$150,000 for light vessels for general lake service. Plans and specifications for two vessels similar in construction to light vessel No. 99 have been completed. Bids were received for the construction of one or both vessels, on January 15, 1918, and on June 5, 1918, a contract was awarded to the Gas Engine & Power Co. and Charles L. Seabury Co., Morris Heights, N. Y., in the sum of \$147,428 for the construction of one vessel, No. 103. It is proposed to invite new bids for light vessel No. 104 when funds are available. Amount expended to June 30, 1918, \$112.22.

Light vessel "No. 105" (Cape Charles).—The act of June 12, 1917, appropriated \$130,000 for a light vessel for Cape Charles, Va., or for general service.

Plans and specifications are nearly completed for a large first-class light vessel or this station. No expenditures were made to June 30, 1918.

SPECIAL WORKS OF CONSTRUCTION COMPLETED (OMITTING VESSELS).

SECOND DISTRICT.

Cape Cod Canal Lights, Mass.—The act of August 1, 1914, appropriated \$50,000 for lighting approaches to Cape Cod Canal, Mass. At eastern entrance, Sandwich, Cape Cod Bay, 1 acetylene high-power gas and bell buoy, 1 Pintsch gas and bell buoy, 1 spar buoy, 1 electric lighted lens lantern on tower located on breakwater 900 feet from outer end; at western entrance, Buzzards Bay, 3 acetylene-gas and bell buoys, and 3 acetylene-gas buoys, 14 acetylene-lighted beacons, 1 first-class can, 1 first-class nun, and 6 spar buoys were established. The candlepower of Wings Neck Light was increased from 180 to 2,900 by installation of fourth-order lens and vapor oil apparatus. Internal-combustion engines and air compressors in duplicate for operating Daboll trumpet have been installed at Wings Neck in place of bell operated by clockwork. Amount expended to June 30, 1918, \$50,624.84.

NINTH DISTRICT.

Navassa Island Light Station, W. I.—The act of October 22, 1913, appropriated \$125,000 for the construction of a light station on Navassa Island located in Windward Passage, 40 miles west of Haiti, West Indies. The construction work was started in January, 1916, and the light went into commission October 21, 1917. The tower is of reinforced concrete 150 feet high and dwelling of reinforced concrete with accommodations for three keepers. Amount expended to June 30, 1918, \$116,159.40.

TENTH DISTRICT.

Ashtabula Harbor, Ohio.—The act of October 22, 1913, appropriated \$45,000 for rearranging, rebuilding, and improvement of aids to navigation in Ashtabula Harbor, Ohio. Under this appropriation the superstructure of the new pierhead at outer end of extended west breakwater has been constructed, the lighthouse structure moved to this pierhead from its old location, and an addition to this structure built. The light was placed in commission September 21, 1916, and the fog signal March 26, 1917. Amount expended to June 30, 1918, \$42,429.72.

Cleveland Harbor, Ohio.—The act of October 22, 1913, appropriated \$17,600 for removal, reconstruction, and improvement of the fog-signal station at Cleveland Harbor, Ohio. A fog-signal building has been constructed, the necessary plant installed, and the signal was placed in commission August 18, 1916. Amount expended to June 30, 1918, \$17,312.82.

Toledo Harbor, Ohio.—The act of July 1, 1916, appropriated \$15,000 for improving the aids to navigation in Toledo Harbor, Ohio. Two skeleton steel towers for Manhattan Range Lights have been erected and the lights were installed in the towers on May 25, 1918. Amount expended to June 30, 1918, \$13,231.81.

SPECIAL WORKS OF CONSTRUCTION UNCOMPLETED (OMITTING VESSELS).

FIRST DISTRICT.

Dog Island, Eastport, Me.—An appropriation of \$3,500 was made by the act of July 1, 1916, for placing an unattended light on Dog Island, Eastport, Me. Immediate steps were taken to procure title to the site, and after considerable delay the matter was placed in the hands of the proper United States district attorney for condemnation proceedings. The court has fixed \$500 as the amount to be paid for site. Payment will be made as soon as unpaid taxes and any liens against the property are adjusted. The date of completion is indefinite. No expenditures were made to June 30, 1918.

SECOND DISTRICT.

Woods Hole, Mass., Lighthouse Depot.—The act of July 1, 1916, appropriated \$50,000 for improvements at Woods Hole Depot, Mass. About 32,000 feet of channel 150 feet wide was dredged to a depth of 17 feet and a basin in front of depot 400 feet by 550 feet was dredged to 17 feet at a cost of \$30,162.97.

A two-story storehouse, 35 feet by 80 feet, of brick with steel frame and reinforced concrete floors and roof was finished by contract August 18, 1917. The electric lighting and equipment will be completed at an early date.

Amount expended to June 30, 1918, \$47,758.51.

THIRD DISTRICT.

Hunts Point, N. Y.—The act of March 4, 1911, appropriated \$5,000 for the establishment of a light and fog signal to mark Hunts Point, between Hell Gate and White-stone Point, East River, N. Y. The work of erecting a structure for the light and fog signal was started in November, 1916, and the light went into commission on January 4, 1917. The structure consists of a steel tower built on a stone and concrete foundation, with the necessary provision made for the establishment of a fog signal later when it is practicable to procure electric current for its operation. The date of the completion of this project is indefinite, but it is expected that it will be possible to get current and have fog signal in operation by June 15, 1919. Amount expended to June 30, 1918, \$3,520.21.

Aids to navigation, Hudson River, N. Y.—The act of July 1, 1916, appropriated \$100,000 for improving the aids to navigation and establishment of new aids on the Hudson River, N. Y. The work of improving, rebuilding, and establishing the aids will affect 24 different points. The work in progress consists in building and equipping barge for the purpose, which was delayed on account of the destruction by fire of the shipyard of the company which had the contract for its construction, taking necessary steps toward the acquisition of required sites and the purchase of the required lighting apparatus. The work was started in December, 1916, and it is expected will be completed about June 15, 1919. Amount expended to June 30, 1918, \$2,036.64.

Staten Island Lighthouse Depot, N. Y.—The act of June 12, 1917, appropriated \$21,000 for improving the offices and laboratory at the general lighthouse depot. Bids for doing the work were opened in May, 1918, but were rejected on account of the lowest bid received being more than the funds appropriated for the purpose. No work has as yet been done under this appropriation. Amount expended to June 30, 1918, \$10.04.

Aids to navigation, East River, N. Y.—The act of June 12, 1917, appropriated \$16,000 for improving the aids to navigation in the East River, N. Y., covers improvements and changes in the present system of lights and the establishment of an additional light. The lighting apparatus has been purchased. Layout of system has been taken up with maritime interests and approved, and steps are now being taken to procure the necessary grants for the parcels of land under water. The work was started in September, 1917, and it is expected will be completed about June 15, 1919. Amount expended to June 30, 1918, \$1,326.

Great Salt Pond Light Station, R. I.—The act of June 12, 1917 appropriated \$20,000 for building a new dwelling and moving the fog signal from the inner to the outer end of the breakwater. Plans for dwelling are completed, and steps are being taken to purchase necessary land. The work was started in November, 1917, and it is expected will be completed by June 15, 1919. No expenditures have as yet been made from this appropriation.

Staten Island Lighthouse Depot, N. Y.—The act of March 28, 1918, appropriated \$60,000 for repairing the wharves at the general lighthouse depot, Tompkinsville, N. Y. It is proposed to remove the old wooden decks, furnish and install additional steelwork, cast-iron pile columns, cleats, manhole frames, covers, and pipe hangers, and place new concrete decks on wharves. Plans for the south wharf, in connection with this work, have been prepared, bids opened, and contract now being made. It will be necessary, on account of incessant use of wharves, to do this work in three sections, one at a time. It is expected that the first section will be completed about October, 1918, and the second section in November, 1919. Amount expended to June 30, 1918, \$12.54.

FOURTH DISTRICT.

Joe Flogger Shoal, Del.—The act of June 20, 1906, authorized \$75,000 for establishing a light and fog signal at or near this shoal. The act of June 30, 1906, appropriated \$40,000 for this purpose, and the act of June 17, 1910, increased the limit of cost for this light and fog signal to \$105,000. No additional appropriation has yet been made. Work on this project has been deferred, as the total amount necessary has not been appropriated and other projects are considered of greater importance. The shoal is now marked by two gas buoys. Amount expended to June 30, 1918, \$603.21.

NOTE.—The sundry civil appropriation act approved July 1, 1918, provided that the unexpended balance of the appropriation of \$40,000 "toward a light and fog signal station on the Joe Flogger Shoal, Delaware River," contained in the act approved June 30, 1906, be made available for establishing gas buoys and improving aids to navigation in the vicinity of Joe Flogger Shoal, Del.

Delaware River, Pa., and Del., aids to navigation.—The act of March 3, 1915, authorized this work and the act of July 1, 1916, appropriated \$80,000 for the purpose. Under this appropriation the following work was completed or under way at the close of the fiscal year, on four structures marking two ranges of the new 35-foot channel:

Chester Range Front: Foundation crib placed at site and a 50-foot structural steel tower erected thereon.

Chester Range Rear: Concrete piers placed on timber grillage, and a 100-foot structural steel tower erected thereon.

Marcus Hook Range Front: Concrete block placed on a pile foundation, and a 72-foot structural steel tower erected thereon.

Marcus Hook Range Rear: Site purchased and contract awarded, foundations excavated, and some work done in placing the concrete foundations for tower, dwelling, and outbuilding. A 100-foot mast was erected to support a temporary light.

Under this appropriation the bell at Fort Mifflin fog signal was replaced by an electric siren.

It is expected that all work under the appropriation will be completed during 1919. Amount expended to June 30, 1918, \$47,761.49.

FIFTH DISTRICT.

Aids to navigation, Cape Charles City, Va.—The act of June 12, 1917, appropriated \$12,800 for improving lights and fog signals leading to Cape Charles City, Va. Plans and specifications have been prepared for Cherrystone Bar Light, to cover a small caisson-type structure which will show an unwatched acetylene and support an automatic fog bell actuated by compressed carbon-dioxide gas. It is anticipated that this structure will be completed by October, 1918. No money has been expended from this appropriation to June 30, 1918.

Aids to navigation, Chesapeake Bay, Md. and Va.—The act of June 12, 1917, appropriated \$29,000 for aids to navigation on the eastern shore of the Chesapeake Bay and tributaries. Requisition has been made on the general depot for one service type S buoy for use in the Susquehanna River. Amount expended to June 30, 1918, \$1,201.80.

Repairing and rebuilding aids to navigation, Atlantic coast.—The act of March 28, 1918, appropriated \$150,000 for rebuilding, repairing, and reestablishing aids damaged by storm and ice, from which \$100,000 was allotted to the fifth district. Thirty-eight minor lights carried away by ice have been rebuilt. Equipment for 8 gaslight installations for minor lights has been purchased. Material for rebuilding all the minor lights has been purchased. Plans and specifications for riprap around 6 screw pile lighthouses damaged by ice have been prepared and bids opened June 15, 1918. Plans and specifications for strengthening the foundation of Tangier Sound Light Station have been prepared. Amount expended to June 30, 1918, \$13,137.77.

SIXTH DISTRICT.

St. Johns River, Fla.—The act of July 1, 1916, appropriated \$66,000 for improving aids to navigation and establishing new aids on the St. Johns River, Fla. One lens lantern light on an 8-foot pipe tower on creosoted piles and one post lantern light on a wooden tower on creosoted piles have been established, and 5 light structures have been rebuilt, using pipe towers on creosoted piles, replacing less permanent construction. Numerous minor improvements have been made to light structures, and several other light structures are nearly completed. A 60-foot pipe tower, 11 smaller pipe towers, and all illuminating apparatus necessary to complete this project are on hand. Two gas buoys are on hand ready to be established at an early date, and 4 unlighted buoys have been changed to larger class and additional buoys have been ordered.

Three unlighted beacons consisting of 5-pile structures have been established in Wilson Channel. Amount expended to June 30, 1918, \$23,237.94.

SEVENTH DISTRICT.

Florida Reefs, Fla.—The act of July 1, 1916, appropriated \$75,000 for establishing additional aids, and repairing and improving existing aids. Under this appropriation part of the illuminating apparatus was ordered and has been delivered. Three attempts have been made to obtain proposals for metal work and glass for the two towers to go on Molasses and Pacific Reefs, but with no success. The date of completion is indefinite. Amount expended to June 30, 1918, \$3,427.56.

EIGHTH DISTRICT.

Aids to navigation, Mississippi River, La.—The act of July 1, 1916, appropriated \$50,000 for the improvement of aids to navigation on the Mississippi River below New Orleans. Contract was entered into June 22, 1917, for furnishing 25 structural-steel towers. The contractor had trouble in securing material and at the end of the year a number of the towers were being inspected by a representative of this Service. Amount expended to June 30, 1918, \$567.57.

Aids to navigation, Atchafalaya Entrance Channel, La.—The act of October 22, 1913, appropriated \$50,000 for establishing aids to navigation in Atchafalaya Entrance Channel, La. During the fiscal year ended June 30, 1916, Point au Fer Reef Light-house and Atchafalaya Entrance Channel Lights Nos. 1, 3, 5, 7, 9, and 2 were completed. A 42-foot motor launch was completed by the United States Naval Station, New Orleans, La., during the fiscal year at a cost of \$6,951.71. Requisition for the necessary gas-lighted buoys has been partly filled at end of year. Amount expended to June 30, 1918, \$36,383.59.

Aransas Pass Light Station, Tex.—The act of October 6, 1917, appropriated \$20,000 for repairing and rebuilding dwellings, outbuildings, and appurtenant structures damaged or destroyed in the hurricane of August 18, 1916. During the fiscal year a contract was awarded for building a dwelling, oil house, T wharf, walks, etc. The contractor commenced work at the station during May, 1918, and at the end of the fiscal year had progressed with driving piles for the foundation of dwelling, outhouses, oil house, walks, and wharf. Amount expended to June 30, 1918, \$5.75.

Galveston Jetty Light Station, Tex.—The act of June 11, 1896, appropriated \$35,000, and the act of May 27, 1908, \$10,000 for establishing a light and fog signal station at or near the outer end of one of the jetties at Galveston Harbor, Tex. Great damage was done the uncompleted structure by the hurricane of August 16-17, 1915, which destroyed the construction wharf, bent the framework of the structure, and washed away much material. Subsequently materials were again assembled, another wharf erected, and the framework straightened. The construction wharf was again washed away in the hurricane of August 18, 1916, and some of the lower struts of the sub-structure were again bent. A portion of the lens for this station was lost in the hurricane of July 5-6, 1916, one box containing parts of same having been washed away from the Mobile Lighthouse Depot. It was replaced from the third district. In March, 1917, the construction wharf was rebuilt for the third time. At the end of May, 1917, the installation of intermediate beams to reinforce struts was completed. A concrete block 40 feet square around foundation piles and in places 10 to 15 feet in depth on northerly and southerly edges was completed during the fiscal year and the illuminating apparatus was installed. A requisition has been made for fog-bell striking machinery for the fog signal, and contract for furnishing and placing riprap around station has been entered into to be paid out of appropriation, general expenses, Lighthouse Service, 1918. The repair work stated above—viz, intermediate beams to reinforce struts of lower and middle sections, the construction wharf necessary to install the intermediate beams, and the building of the concrete block—were paid for from the appropriation, general expenses, Lighthouse Service, 1917, as this work was necessary before light could be established. The light has not been exhibited, due to the extinguishment of lights at the entrance to Galveston Harbor by orders of the Navy Department. Amount expended to June 30, 1918, \$44,649.86.

Repairing and rebuilding aids to navigation, Gulf of Mexico.—The act of February 28, 1916, appropriated \$200,000 for repairing and rebuilding aids to navigation damaged or destroyed by hurricanes on the Gulf of Mexico. In addition to the work which had been completed, as stated in the annual report for the fiscal year ended June 30, 1917, there is given below a list of the work that has been completed during present fiscal year and that in progress. During the fiscal year the following portions of the work have been completed:

Bolivar Point Light Station, Tex.: Construction of two frame dwellings supported on high iron columns which rest on pile foundations, oil house, outhouses, and fences.

Chefuncte River Light Station, La.: New cypress sheet-pile breakwater on east and west sides of station; repair of boathouse and wharf; fence rebuilt.

Lake Borgne Light Station, Miss.: Boathouse and wharf on creosoted piles; walks and platforms, rebuilt; dwelling repaired.

Pointe aux Herbes Light Station, La.: New cypress sheet-pile breakwater, about 750 feet long, new walks, and outhouse replaced on new foundation.

Round Island Light Station, Miss.: New wharf on creosoted piles with creosoted stringers, headers, and braces; boathouse in the water and fences repaired.

The following work is in progress at the end of the fiscal year:

Bayou St. John Light Station, La.: Repairing wharves to lights, platform around main light, fence and walks at dwelling, etc.

Calcasieu Light Station, La.: Material has been ordered to rebuild 1,420 feet of walk, 50-foot wharf to range light, etc.

Cape San Blas Light Station, Fla.: A part of the material required to move this tower to a new site further inshore was purchased from this appropriation. This work is now in progress.

Cat Island Light Station, Miss.: New wharf on creosoted piles with creosoted stringers, headers, and braces; new boathouse on square, sawn, creosoted piles with cast-iron pipe sleeves; new platform under station, etc.

Galveston Depot, Tex.: Creosoted piles, caps, and joists have been ordered for depot wharf.

Pass Manchac Light Station, La.: Rebuilding 125 feet of cypress sheet-pile breakwater, storehouse, and boathouse on creosoted piles, fence, etc.

Sabine Bank Light Station, Tex.—Iron shell plates, davits, foot plates, railing, etc., were received during fiscal year and are being installed. The veranda floor of light-house will be closed in with cast-iron plates and davits raised. Amount expended to June 30, 1918, \$159,690.77.

The act of September 8, 1916, appropriated \$125,000 for repairing and rebuilding aids to navigation damaged or destroyed by hurricanes on the Gulf of Mexico, of which \$122,200 was allotted for this district. In addition to the work which had been completed, as stated in the annual report for the fiscal year ended June 30, 1917, there is given below a list of the work that has been completed during present fiscal year and that in progress. During the fiscal year the following portions of the work have been completed:

Grand Batture Island Shoal Beacon 8, Miss.: Single iron-cased pile structure rebuilt.

Great Point Clear Light, Ala.: Pyramidal structure on 9 iron-cased creosoted piles, showing oil lens lantern light, rebuilt.

Gulftort Channel Light No. 1, Miss.: House surmounted by pyramid on 9 iron-cased creosoted piles, showing oil lens lantern light, rebuilt.

Horn Island Light Station, Miss.: New steps and minor repairs.

Horn Island Cut Beacon, Miss.: Slatted pile structure on mud sill, rebuilt.

Mobile Channel Lights Nos. 2, 4, 6, 8, 12, 14, 18, 20, 22, 24, 28, 32, 36, and Cut-off Channel Beacon 4, Ala.: Thirteen structures, each on 9 iron-cased creosoted piles, supporting house surmounted by pyramid, from which acetylene lens lantern light is shown, and 1 single iron-cased creosoted-pile day beacon, rebuilt.

Mobile Channel Lights Nos. 10, 16, 26, 30, 34, 38, 40, and 42, Ala.: Eight structures repaired or partially rebuilt, showing acetylene lens lantern lights.

Mobile Point Beacon Light, Ala.: Pyramidal structure on mud sills supported by 4 creosoted piles, showing oil lens lantern light, rebuilt.

Pascagoula River Lights A and B, and Beacons 2 and 6, Miss.: Two pyramidal structures, each on nine iron-cased creosoted piles, showing oil lens lantern light, and two single iron-cased creosoted-pile beacons, rebuilt.

Pensacola Bay Range Front Light, Fla.: Nine iron-cased creosoted-pile structure, supporting house with pyramidal lantern support, showing oil-lens lantern, rebuilt.

Round Island Light Station, Miss.: Fences, walks, boathouse on shore and dwelling repaired.

Round Island South Spit Light, Miss.: Pyramidal structure on nine iron-cased creosoted piles, showing oil lens lantern light, rebuilt.

Sand Island Light Station, Ala.: Two thousand and seven hundred tons of rock, ranging in weight from 1 to 4 tons each piece, were placed around the tower. New boathouse on eight creosoted piles built.

Ship Island South Channel Range Rear Light, Miss.: Pyramidal structure on four creosoted piles, showing oil lens lantern light, rebuilt.

South Pass West Jetty Range Rear Light, La.: Pyramidal structure on four iron-cased creosoted piles, showing acetylene reflector light, rebuilt. Walk from river to light repaired.

The following work is in progress at the end of the fiscal year:

Cape San Blas Light Station, Fla.: Move tower to a point further inshore because of the encroachment of the sea. A wharf and walk about 1,925 feet long was built from old site of tower to proposed new site, the tower taken down, and 21 of the 36 creosoted piles for new foundation of tower were driven. Amount expended to June 30, 1918, \$97,266.43.

The act of March 28, 1918, appropriated \$100,000 for rebuilding, repairing, and reestablishing aids to navigation and structures connected therewith on the coast of the Gulf of Mexico damaged or destroyed by hurricanes.

Fifty thousand feet board measure creosoted, square, sawn pine piles have been ordered to rebuild aids to navigation; materials have been assembled to commence rebuilding Deer Point and Fair Point Lights, Fla. Amount expended to June 30, 1918, \$5.31.

Sabine Pass Light Station, La.—The act of May 27, 1908, appropriated \$40,000 for a light and fog signal at or near the end of Sabine Pass Jetty. Nothing has been done on the work, in view of the proposed project of the War Department to extend the jetties to the 25-foot contour, a distance of possibly 2 miles. At the close of the fiscal year 1918 no money had been expended or obligated.

NINTH DISTRICT.

Point Borinquen Light Station, P. R.—The act of June 12, 1917, appropriated \$85,000 for the construction of Point Borinquen Light Station. Plans and specifications have been prepared, and steps have been taken to purchase the site. No work has been done or expenditures made under this appropriation to June 30, 1918.

TENTH DISTRICT.

Lorain Harbor, Ohio.—The act of October 22, 1913, appropriated \$35,000 for a light and fog-signal station and improvement of aids to navigation at Lorain Harbor, Ohio. The concrete structure has been erected and temporary light placed in operation in the new lantern. The interior of building, outside steps, railing, etc., remain to be completed. Amount expended to June 30, 1918, \$32,443.71.

Conneaut Harbor, Ohio.—The act of July 1, 1916, appropriated \$63,500 for a light and fog-signal station and improving aids to navigation at Conneaut Harbor, Ohio. Detail plans for the structure have been approved. Concrete foundation completed. Contracts have been awarded for the metal work, brick, and stone. Owing to existing conditions regarding deliveries, etc., active work of erecting the superstructure will probably have to be deferred until next season. Amount expended to June 30, 1918, \$21,681.40.

Huron Harbor, Ohio.—The act of June 12, 1917, appropriated \$4,500 for establishing aids to navigation at Huron Harbor, Ohio. Contract has been made for the steel tower for rear range light. Amount expended to June 30, 1918, \$11.84.

Fairport Harbor, Ohio.—The act of June 12, 1917, appropriated \$42,000 for improving aids to navigation at Fairport Harbor, Ohio. Amount expended to June 30, 1918, \$400.

ELEVENTH DISTRICT.

Detroit River, Mich.—The act of March 4, 1911, appropriated \$210,000 for establishing aids to navigation along the Livingstone Channel, Detroit River, Mich., including authority to locate and construct lights and to place buoys necessary to properly mark this channel. To June 30, 1918, 12 concrete piers have been completed and 9 beacon lights placed in commission. The other 3 await completion of contemplated changes in the channel before they can be utilized. Thirteen gas buoys and 21 spar buoys are now used to mark the channel in addition to the lights on piers. Plans have been prepared for the construction of a light and fog signal near the southern end of the channel which, if carried out, will relieve a lightship now maintained in the locality and which is becoming badly deteriorated, requiring early condemnation. Two additional pier lights will be established, taking the place of gas buoys now maintained on the west side. This can not be done until the proposed channel widening has been completed. In addition to the lights along the channel proper a semaphore system for controlling the movements of vessels through the channel has been constructed and placed in operation. One of the semaphores, giving the first warning to vessels, has been moved to a point farther away from the entrance of the channel in order that vessels checked by it may have more room for anchorage and maneuver in case of necessity. The semaphore lights for this station have been changed from oil to acetylene, with a resultant increase in power. Total expenditure to June 30, 1918, \$168,713.02.

Aids to navigation, Fighting Island Channel, Detroit River, Mich.—The act of July 1, 1916, appropriated \$25,000 for aids to navigation, Fighting Island Channel, Detroit River, Mich. Under this appropriation a nonattended acetylene flashing light has been established at the southern entrance on the east side of the channel, and a similar light at the northern entrance on the east side, these lights being known as Fighting Island South and North Lights, respectively. Intermediate, between the above permanent lights on the east side, are installed three type S acetylene-gas buoys at approximately equal intervals. On the west side and approximately opposite the three gas buoys two permanent lights are maintained, with one type S acetylene-gas

buoy intermediate. Fighting Island South Light was placed in commission in November, 1916, and the North Light in December, 1917. Gas-buoy stations were marked temporarily by Pintech gas buoys pending the installation of acetylene buoys, which were placed on station at the opening of navigation 1918. Four ranges along the channel, formerly maintained, are now eliminated, single lights being maintained in each case, as the channel is now straight for the entire distance. It is expected that two of the lights from these old ranges will be altered to nonattended acetylene during the coming year. The Fighting Island North Light, which was constructed in 13 feet of water and completed during the last year, serves an important purpose in providing a light at the entrance to the channel in the spring before buoys can be placed and in the fall after their removal is necessary. It further serves as a location for one of the Livingstone Channel semaphore stations. Amount expended to June 30, 1918, \$13,110.36.

Sand Hills Light Station, Mich.—The act of June 12, 1917, appropriated \$70,000 for the establishment of a light station and fog signal at or near Sand Hills, Mich. During the past season the site has been surveyed and purchased. Materials for the station are practically all delivered and necessary clearing operations practically completed, the foundation of the dwellings and tower completed, and other construction well started. Work is now proceeding rapidly, and it is anticipated that the fog signal and probably also the main light at this station will be placed in commission during the current season. During the period of construction and until the light and fog signal are in operation a temporary lens-lantern light is being maintained, and an electrically operated siren is being used as a fog signal. The buoy formerly maintained on the shoal has been discontinued, owing to the establishment of the temporary light. Amount expended to June 30, 1918, \$29,941.08.

Aids to navigation, Keweenaw Waterway, Mich.—The act of June 13, 1917, appropriated \$100,000 for aids to navigation, Keweenaw Waterway, Mich. During the past season a necessary preliminary examination of the site for the main light and fog-signal structure was carried out. Steps were taken to secure rights of way for electric power lines. The consent of the War Department was obtained for occupancy of land and structures and construction work on the main light and fog-signal structure actively started. The plans which have been approved and are now being carried out contemplate electrification of all beacons in the Portage River as far north as Portage Lake, service to all being given by an electric line connecting with a generating station located at Portage Entry. An air-compressing plant established at the same location will furnish power for operating a first-class siren at the new light and fog-signal station on the pierhead. The main light will also be electric, supplied with power from the main generating station. Quarters will be provided for three keepers and the necessary minor structures in connection with the station provided. All beacons in that portion of the river under improvement will be reconstructed in permanent form except where they are subject to possible changes in location due to proposed channel improvements. A derrick scow for use in connection with the construction of this station has been completed during the year and is now being employed on the work. Amount expended to June 30, 1918, \$15,579.69.

TWELFTH DISTRICT.

White Shoal, Mich.—The act of March 4, 1907, appropriated \$250,000 for a light and fog-signal station at White Shoal, Mich., in the north end of Lake Michigan, to replace the White Shoal Light Vessel. Tower was completed and light placed in commission September 1, 1910; fog signal placed in commission September 15, 1910; submarine bell established September 20, 1911; water-supply system installed October, 1911; oil-storage system installed June, 1913; auxiliary flashing winter light established December, 1914. Equipment of three boat cranes with air-driven hoists under way; \$1,900 allotted from special appropriation for this purpose. Amount expended to June 30, 1918, \$226,494.03.

Chicago Harbor, Ill.—The act of June 12, 1917, appropriated \$88,000 for the removal of the Chicago Harbor Light and Fog Signal from its present location to the south end of the north arm of the extension of the exterior breakwater and rebuilding the station. Skeleton steel towers are to be erected on both the north and south ends of the south-arm extension and are to be equipped with acetylene lights. Light and fog signal have been discontinued at old site; fog signal established at new site; concrete base completed; tower removed from old site and partially erected on new concrete base; steel fog signal and boat houses being fabricated at shop; temporary acetylene construction light established at new site; steel towers and acetylene equipment for south-arm extension purchased; north-end light, south-arm extension, to be established and main light to be reestablished this season. Amount expended to June 30, 1918, \$55,093.18.

Indiana Harbor, Ind.—The act of June 12, 1917, appropriated \$100,000 for the establishment and improvement of aids to navigation at Indiana Harbor, Ind. Light-house tower and fog signal to be erected at east end of north arm of the breakwater. A skeleton steel tower is to be erected on the north end of the south arm on a concrete base and acetylene light installed. Amount expended to June 30, 1918, \$28.

Manitowoc Breakwater, Wis.—The act of June 12, 1917, appropriated \$21,000 for improving the light and fog-signal station at Manitowoc, Wis.; new steel fog-signal and light station to be erected; improved light to be established, and first-class air siren and compressors to be installed; old structure removed from end of breakwater; concrete sub-base for the tower is being built by United States engineers; contract let for steel work for tower and fog-signal house; concrete foundation to be built by United States engineers. Amount expended to June 30, 1918, \$964.23

SIXTEENTH DISTRICT.

Aids to navigation, Alaska.—The acts of August 1, 1914, and June 12, 1917, each appropriated \$60,000 for establishing and improving aids to navigation in Alaskan waters. During the fiscal year 1918 one gas buoy, 1 oil post lantern, and 6 acetylene lights were established from the above appropriations. Illuminating apparatus and other material were purchased for 8 additional acetylene lights and 3 gas buoys, and of these several were nearing completion at the close of fiscal year 1918. On June 30, 1918, the balance from the appropriation of August 1, 1914, had been expended. Amount expended to June 30, 1918, \$96,847.38.

SEVENTEENTH DISTRICT.

Aids to navigation, Puget Sound, Wash.—The act of October 22, 1913, appropriated \$30,000 for aids to navigation and improvements in existing aids in Puget Sound and adjacent waters, Washington. Under this appropriation the following work has been performed:

Marrowstone Point Light Station, Wash.: A new light and fog-signal building was built at a cost of \$1,112.13. Change in light from acetylene to electric was made at a cost of \$311.54. Change in fog signal from acetylene gun to third-class Daboll trumpet, operated by an electrically driven rotary compressor unit, was made at a cost of \$2,771.61.

Apple Cove Point, Wash.: An acetylene flashing light was established on this point at a cost of \$1,106.

Amount expended to June 30, 1918, \$29,216.17.

Kellett Bluff Light Station, Wash.—The sundry civil act approved July 1, 1916, appropriated \$40,000 for establishing a light and fog-signal station at or near Kellett Bluff, Henry Island, Wash., or at some point on the west coast of San Juan Island, Wash. After due consideration, the point known as Lime Kiln, on the west coast of San Juan Island, was decided upon as a location for this aid, to be known as Lime Kiln Light Station and to consist of a fourth-order flashing light and third-class fog signal. Proposals were invited for the construction of the buildings, but the bids, being considered excessive, were rejected and it was decided to perform the work by hired labor. The work will be started in the early part of the next fiscal year. Amount expended to June 30, 1918, \$3,095.54.

Aids to navigation, Coquille River, Oreg.—No active operations have been carried out on this project during the year, for which \$6,000 was appropriated by sundry civil act of July 1, 1916, first on account of uncertainty as to the stability of the site (enrockment of South Jetty), and second on account of recent opposition to the transfer of the light from its present location, a matter which is now under investigation. Amount expended to June 30, 1918, \$36.34.

Aids to navigation, Washington and Oregon.—The sundry civil act approved June 12, 1917, appropriated \$35,000 for new aids and improvements to existing aids. Materials for the installation of four occulting acetylene light installations have been purchased and are being assembled. Amount expended to June 30, 1918, \$192.11.

EIGHTEENTH DISTRICT.

Point Vincente, Cal.—The act of July 1, 1916, appropriated \$80,000 for establishing a light and fog signal at Point Vincente, Cal. The site was under controversy, and the United States attorney prepared the data preliminary to entering suit for condemnation of suitable site; action has been deferred and the condemnation suit has been postponed. Sketch drawings have been approved, detail drawings of a reinforced concrete tower have been approved, and detail drawings of keepers' quarters have been prepared. The Bureau standard cylindrical helical bar lantern, 9 feet 9 inches inside diameter, will be used. The lens is being assembled at the general depot. The date of completion will depend upon the acquisition of site. Amount expended to June 30, 1918, \$13.50.

NINETEENTH DISTRICT.

Aids to navigation, Pearl Harbor, Hawaii.—The act of March 3, 1915, authorized \$80,000 for establishing aids in Pearl Harbor, which amount was appropriated by act of June 12, 1917. Location of aids determined and borings made. Privilege to occupy sites and lay necessary cable secured. System of lights satisfactory to the Navy Department has been approved. Preliminary plans of the proposed structures now under consideration by the Bureau. Two gas buoys for this project purchased and part of apparatus for same has been received. Amount expended to June 30, 1918, \$1,192.91.

UNEXPENDED BALANCES ON JUNE 30, 1918, FROM APPROPRIATIONS FOR SPECIAL WORKS.

District.	Title of appropriation.	Acts.	Balance.
General....	Repairing and rebuilding aids to navigation, Atlantic coast.	Mar. 28, 1918.....	\$138,742.24
	Tender for first lighthouse district.....	May 27, 1908.....	4,298.15
	Light vessels for general service.....	Aug. 24, 1912; Aug. 26, 1912.....	148,894.31
	Lighthouse tender, general service.....	June 25, 1915.....	1,718.24
	Light vessels for general lake service.....	June 12, 1917.....	149,887.78
	Radio installations on lighthouse tenders.....	do.....	59,976.88
	Oil houses for light stations.....	June 25, 1910.....	388.55
2d.....	Cape Cod Canal Lights, Mass.....	Aug. 1, 1914.....	1,951.49
	Woods Hole Lighthouse Depot, Mass.....	July 1, 1916.....	2,241.49
	Nantucket Harbor Fog Signal, Mass.....	Mar. 28, 1918.....	15,000.00
3d.....	Newark Bay Beacon Lights, N. J.....	Mar. 4, 1907; Oct. 22, 1913.....	82.19
	Staten Island Lighthouse Depot, N. Y. (carpenter's shop).....	Mar. 3, 1901; June 28, 1902.....	827.90
	Hunts Point Light Station, N. Y.....	Mar. 4, 1911.....	1,479.79
	Aids to navigation, Hudson River, N. Y.....	July 1, 1916.....	99,753.01
	Tender for third lighthouse district.....	June 12, 1917.....	149,927.63
	Aids to navigation, East River, N. Y.....	do.....	15,999.00
	Great Salt Pond Light Station, R. I.....	do.....	20,000.00
	Staten Island Lighthouse Depot, N. Y. (wharves).....	Mar. 28, 1918.....	600.00
4th.....	Aids to navigation, Delaware River, Pa. and Del.....	July 1, 1916.....	32,338.51
5th.....	Thimble Shoal Light Station, Va.....	June 25, 1910.....	2,044.55
	Lighting Norfolk Harbor, Va.....	Mar. 4, 1911.....	2,121.20
	Cape Charles Light Vessel, Va.....	June 12, 1917.....	130,000.00
	Aids to navigation, Cape Charles City, Va.....	do.....	12,800.00
	Aids to navigation, Chesapeake Bay, Md. and Va.....	do.....	29,000.00
6th.....	Tender engineer, sixth lighthouse district.....	Apr. 28, 1904.....	396.46
	Aids to navigation, St. Johns River, Fla.....	July 1, 1916.....	42,762.06
7th.....	Aids to navigation, Florida Reef, Fla.....	do.....	4,072.44
8th.....	Galveston Jetty Light Station, Tex.....	June 11, 1896.....	350.14
	Sabine Pass Jetty Light Station, Tex.....	May 27, 1908.....	40,000.00
	Southwest Pass Light Vessel, Mississippi River.....	Oct. 22, 1913.....	14,404.75
	Aids to navigation, Atchafalaya Entrance Channel, La.....	do.....	15,666.41
	Repairing and rebuilding aids to navigation, Gulf of Mexico.	Feb. 28, 1916; Sept. 8, 1916; Mar. 28, 1918.....	165,492.73
	Aids to navigation, Mississippi River, La.....	July 1, 1916.....	49,432.43
	Tender and barge, for eighth lighthouse district.....	do.....	19,986.86
9th.....	Aransas Pass Light Station, Tex.....	Oct. 6, 1917.....	19,994.25
	Navassa Island Light Station, West Indies.....	Oct. 22, 1913.....	3,948.32
	Point Boringuen Light Station, P. R.....	June 12, 1917.....	85,000.00
10th.....	Cleveland Fog-signal Station, Ohio.....	May 27, 1908.....	289.03
	Aids to navigation, Ashtabula Harbor, Ohio.....	Oct. 22, 1913.....	2,605.17
	Aids to navigation, Lorain Harbor, Ohio.....	do.....	2,556.29
	Aids to navigation, Conneaut Harbor, Ohio.....	July 1, 1916.....	41,818.60
	Aids to navigation, Toledo Harbor, Ohio.....	do.....	1,768.19
	Aids to navigation, Huron Harbor, Ohio.....	June 12, 1917.....	4,488.16
	Aids to navigation, Fairport Harbor, Ohio.....	do.....	41,600.00
11th.....	Superior Pierhead Range Lights, Wis.....	June 30, 1906.....	1,917.10
	Detroit River Lights, Mich.....	Mar. 4, 1911.....	41,286.98
	Aids to navigation, Fighting Island Channel, Detroit River, Mich.....	July 1, 1916.....	11,889.64
	Sand Hills Light Station, Mich.....	June 12, 1917.....	40,058.92
	Aids to navigation, Keweenaw Waterway, Mich.....	do.....	89,420.31
12th.....	White Shoal Light Station, Lake Michigan.....	Mar. 4, 1907.....	23,505.97
	Chicago Harbor Light Station, Ill.....	June 12, 1917.....	32,906.32
	Manitowoc Breakwater Light Station, Wis.....	do.....	20,035.77
	Aids to navigation, Indiana Harbor, Ind.....	do.....	99,972.00
16th.....	Aids to navigation, Alaska.....	June 12, 1917.....	23,152.62
	Cape St. Elias Light Station, Alaska.....	Oct. 22, 1913.....	297.61
17th.....	Aids to navigation, Puget Sound, Wash.....	do.....	783.83
	Kollett Bluff Light Station, Wash.....	July 1, 1916.....	36,904.46
	Aids to navigation, Coquille River, Oreg.....	do.....	5,963.66
	Aids to navigation, Washington and Oregon.....	June 12, 1917.....	34,807.89
18th.....	Point Vicente Light Station, Cal.....	July 1, 1916.....	79,986.50
19th.....	Aids to navigation, Pearl Harbor, Hawaii.....	June 12, 1917.....	78,807.00

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
1st.....	E. L. Farren, keeper, Eagle Island Light Station, Me. Tender Hibiscus.....	Sloop..... Mall boat.....	Rendered assistance to sick captain of sloop. Rescued 3 men endeavoring to carry mail across West Penobscot Bay, Me., on the ice, with aid of small boat, and repaired boat. But for timely arrival of Hibiscus, men, mail, and boat would probably have been lost.
	Tender Zizania.....		Proceeded, through heavy ice, to Mark Island, West Penobscot Bay, Me., distance of 15 miles; procured physician for man with broken leg, and landed him at Islesboro, Me., after medical assistance was rendered.
	Tender Hibiscus.....	Small boat.....	Rescued woman and son from distressed boat.
	Do.....	Power boat Oyama.	Towed disabled boat with 2 men aboard to New Harbor, Me.
	P. L. Marr, keeper, The Cuckolds Light Station, Me.	Schooner Annie and Reuben.	Signaled life-saving crew and assisted in piloting them and running line to distressed schooner, ashore in fog near station.
	E. V. Talbot, assistant keeper, The Cuckolds Light Station, Me.	Motor boat Quit....	Assisted in getting ashore a party of 7 men and women in motor boat lost in fog and filling with water; sounded distress signal and furnished party dry clothing and refreshments.
	J. E. Purington, keeper, Nash Island Light Station, Me. L. B. Dudley, keeper, Saddleback Ledge Light Station, Me. H. G. Sawyer, keeper, Bear Island Light Station, Me. J. W. Jallison, keeper, Tenants Harbor Light Station, Me.	Power boat..... Power boat; Benj. Hollett, owner. Motor boat..... .....do.....	Furnished lodging to party of 5 from disabled boat. Furnished lodging and gasoline to occupant. Towed disabled boat with occupant to Northeast Harbor, Me. Towed disabled boat to safe anchorage through strong wind and rough sea.
	Tender Zizania.....		The tender Zizania proceeded to Vinalhaven, Me., with mail, passengers, and provisions, that town having been shut off from all sources of supplies for upward of 11 days on account of severe weather and ice conditions. She later returned to Vinalhaven and took aboard passengers, mail, and freight, and proceeded to Rockland; towed disabled boat, with 4,000 live lobsters on board, to Rockland; assisted schooner jammed in the ice.
2d.....	Tender Azalea.....	Tug W. S. Taylor, Potter Transportation Co.	Towed disabled tug to Boston Bay, Mass., where another tug took her for docking.
	J. E. H. Cook, keeper, Cape Ann Light Station, Mass.	Motor boat from schooner Commonwealth.	Furnished food and transportation to mainland to 2 fishermen adrift 4 days.
	E. C. Mott, keeper, Deer Island Light Station, Mass. F. E. Davis, keeper, Duxbury Pier Light Station, Mass.	Motor boat; John J. Grant, owner. Motor boat.....	Towed disabled motor boat with party of 5 to safe anchorage. Towed disabled boat with party of 3 to Plymouth, Mass.
	Tender Anemone.....	U. S. S. Lakewood and 2 tugs.	Attempted to pull steamer Lakewood off shoal, and towed 2 tugs to her to lighten her cargo of coal.
	Tender Azalea.....	Tug Mexpet; Mexican Petroleum Co., owners.	Towed disabled tug and barge to Vineyard Haven, Mass., and put to anchor.
	Do.....	Steamer Ruby.....	Went to assistance of stranded steamer.
	Tender Anemone.....	U. S. S. minesweeper Whitecap.	Assisted in floating mine sweeper stranded on rocks.
	Tender Azalea.....	Barge Arenac; W. McCormack, owner.	Towed disabled barge in sinking condition to Vineyard Haven, Mass.

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
2d.....	C. H. Jennings, keeper, Boston Light Station, Mass.	U. S. S. Alacrity....	Assisted in endeavor to float stranded steamer under dangerous ice and weather conditions; carried dory across island over icy and slippery rocks; transferred crew and dunnage aboard when ship was about to be floated; furnished crew with food.
3d.....	Tender Daisy.....	Power yacht Eileen III; Harry B. Newman, owner.	Towed disabled yacht with party on board to landing of Lake Champlain Yacht Club.
	J. McDougall, keeper, Coxsackie Light Station, N. Y.	Power launch Lafalot; D. J. Mahoney, New York, owner.	Extinguished fire on launch.
	E. J. Rathbun, keeper, Point Judith Light Station, R. I.	Power boat.....	Assisted in recovering 2 men during rough weather and high sea from capsized boat, and endeavored to revive men.
	C. R. Riley, keeper, Bridgeport Breakwater Light, Conn.	Power boat; Oren Barber, owner.	Rescued man and wife from disabled and sinking boat, ashore on breakwater, and furnished them food and shelter.
	J. Marshall, fireman, Orlandi Orlando, seaman, tender Daisy.	.....	Rescued from drowning in strong flood tide 2 men thrown into water from capsized boat.
	V. Knies, assistant keeper, Whale Rock Light Station, R. I.	Motor dory Nadine; Jos. Sambrook, owner.	Repaired disabled engine of boat and towed boat to Newport.
	R. C. Ridgway, assistant keeper, Rockland Lake Light Station, N. Y.	Motor boat.....	Rescued man, wife, and 2 children from motor boat, ashore on rocks and in sinking condition; pulled boat off rocks and brought party to station.
	E. Jansen, keeper, Lime Rock Light Station, R. I.	Boat.....	Rescued 2 men during storm from boat and took them and their provisions to their barges.
	Relief Light Vessel No. 78 on Fire Island Light Vessel No. 68 station, N. Y.	Schooner Edith M. Prior.	Furnished schooner, in leaking condition, water, provisions, and coal.
	Tender Myrtle.....	Transport Laplund.	Assisted in recovering lifeboat unhooked and capsized.
	K. Niblett, keeper, Great Beds Light Station, N. J.	.....	Towed oyster skiff, adrift, to station; thence to Perth Amboy, N. J.
	W. J. Murray, keeper, Sylvester Kendzia, first assistant keeper, Paul G. Petersen, second assistant keeper, Little Gull Island Light Station, N. J.	.....	Assisted in transferring mail, etc., from shore to outer end of wharf at Fort Mifflin, N. Y., damaged by storm.
	G. J. Thomas, keeper, Fire Island Light Station, N. Y.	.....	Rescued 2 aviators from sinking hydroplane, in Great South Bay, and transported them to aviation camp at Bay Shore.
	R. G. Hendricks, laborer in charge, Fitchs Point, White Rock Reef, and Long Beach Lights, Conn.	.....	Rescued boy marooned on Cockenoe Island for 36 hours on account of storm, and took him home.
	Tender Larkspur.....	S. S. City of Montgomery.	Rescued frozen and nearly unconscious sailor who had fallen overboard, furnished medical attention, dry clothes, and took him to hospital.
	Tender Myrtle.....	Gasoline power boat Mary Ella.	Towed boat, ice bound in Narrows, New York Bay, to landing at Stapleton, Staten Island.
	.....do.....	Launch from H. M. S. Carnaral.	Towed launch through ice to berth alongside H. M. S. Carnaral.
	Tender Tulip.....	Tail of the Horse Shoe Light Vessel No. 46, Va.	Went to assistance of light vessel under rigorous and hazardous weather conditions.
	Tender Mistletoe.....	Bartlett Reef Light Vessel No. 13, Conn.	Salvaged light vessel, adrift on rocks, in storm, and rescued men.
	Tender Larkspur.....	U. S. S. Indiana.....	Endeavored to pull off steamer ashore on East Bank Bay, N. Y.
	Tender Tulip.....	U. S. S. Pickering....	Towed disabled steamer to New London, Conn.
	Tender Pansy.....	Power boat; S. W. McKeever U. S. Shipping Board.	Towed disabled and leaking boat to U. S. Government Dock, Rockaway Point.

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
3d.....	W. J. Murray, keeper, Paul Peterson, first assistant keeper, Stanley H. Rood, second assistant keeper, Little Gull Island Light Station, N. Y. E. Hoxsie, keeper, Great Salt Pond, etc., Lights, R. I. Quartermaster of Myrtle and quartermaster of Larkspur.	Schooner Francis.....	Rescued man, adrift on ice, and nearly unconscious from exposure; took him to station, and afterwards sent him to hospital at Fort Michie. Piloted schooner out of harbor.
	G. J. Thomas, keeper, Fire Island Light Station, N. Y.		Assisted in rescuing watchman of American Dock Co., who had fallen overboard, clinging to pile and exhausted.
	Tender John Rodgers.....		Assisted in extinguishing fire which burned several cottages, fishing buildings, etc.; also pulled from surf a floating ball resembling a mine.
	D. Griffiths, keeper, J. H. Bentley, assistant keeper, Southwest Ledge Light Station, Conn. Fire Island Light Vessel No. 68, N. Y. Five Fathom Bank Light Vessel No. 79, N. J.	Motor launch Radima.....	Assisted in extinguishing fire which endangered clubhouse and part of Jersey Central Dock at Highlands.
	Northeast End Light Vessel No. 44, N. J.		Towed disabled launch in rough sea to station.
	W. Tengren, keeper, Bullock Point Light Station, R. I.	Schooner Edna.....	Towed aeroplane with two occupants to ship.
	Tender Tulip.....	Barge Henry Failing, of New York.	Assisted in lifting anchor of water-logged schooner when ready to be towed by tug.
4th.....	G. A. Holston, keeper, Lewes Lighthouse Depot, Del. do.....	Barge Maine.....	Towed disabled aeroplane to vessel and signaled for assistance.
	do.....	Launch.....	Rescued 2 men and 2 women in danger of drowning, from capsized boat, and brought them to station.
	Tender Iris.....	Navy S. P. No. 682.....	Towed barge to Harbor of Refuge, Del., and anchored it behind breakwater.
	W. H. Schellenger, keeper, R. C. Taylor, first assistant keeper, Harbor of Refuge Light Station, Del.	Schooner Jesse L. Leach.....	Repaired disabled engine of barge during severe storm.
5th.....	Fenwick Island Shoal Light Vessel No. 52, Del. A. J. Jarvis, assistant keeper Maryland Point Light Station, Md. Tender Maple.....	Aeroplane.....	Kept floating wreckage from damaging launch No. 66 during terrific storm.
	C. B. Stowe, assistant keeper, Laurel Point Light Station, N. C.	Hydroplane.....	Recovered disabled motor boat.
	J. E. Stubbs, assistant keeper, Craney Island Light Station, Va. W. F. McDorman, assistant keeper, Holland Island Bar Light Station, Md.	Gas boat.....	Extinguished fire in an electric-welding machine, in close proximity to a barge containing 500 barrels of mineral oil.
	A. Midgett, keeper Harbor Island Bar Light Station, N. C. E. Davis, keeper, J. M. Marchand, assistant keeper, Windmill Point Light Station, Va.	Small boat.....	Rendered assistance to officers and crew of disabled schooner and furnished them food and shelter.
	I. C. Meekins, keeper, Croatan Light Station, N. C.	Schooner Admira.....	Rendered assistance to disabled aeroplane with 2 occupants.
	W. G. Rollinson, keeper, Hatteras Inlet Light Station, N. C.		Rendered assistance to disabled aeroplane with 1 occupant.
	Tender Orchid.....	Schooner A. L. White.....	Rendered assistance to disabled hydroplane with 1 occupant.
		Tail of the Horse-shoe Light Vessel No. 46 and 35 Foot Channel Light Vessel No. 45, Va.	Rendered assistance to gas boat caught in gale; also made repairs to boat.
			Rescued from drowning 3 young men whose boat capsized.
			Performed duty faithfully during severe ice conditions.
			Assisted in floating schooner.
			Performed duty faithfully during hazardous ice conditions.
			Do.
			Assisted in floating schooner; obtained medical treatment for member of crew.
			Rendered assistance to both light vessels during hazardous ice conditions.

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
5th.....	Tail of the Horseshoe Light Vessel No. 46, Va. C. W. Pugh, keeper, Roanoke Marshes Light Station, N. C. Tender Maple.....	Steamer E. R. Daniels. 2 large gas buoys....	Performed duty faithfully during hazardous ice conditions. Assisted steamer in getting out of ice and towed her to shore. Picked up 2 large gas buoys in Chesapeake Bay during hazardous ice conditions. Extinguished fire which threatened to destroy tender. Rendered courageous services in extinguishing fire on tender. Rendered assistance to schooner caught in ice. Assisted in floating schooner.
	Tender Juniper.....		
	D. E. Christiansen, seaman, tender Juniper.		
	Tender Jessamine.....	Schooner Otis Hubbard.	
	Tender Maple.....	Schooner Mary Vickers.	
	Tender Jessamine.....	Gasoline supply boat Speedway.	Floated gasoline supply boat.
	Tender Juniper.....	Schooner Annie Edwards.	
	do.....	Schooner R. L. Davis	Assisted in floating schooner from reef to safe anchorage. Floated schooner.
	O. O. Johnson, keeper, Cobb Point Barr Light Station, Md.	Motor boat.....	Rendered assistance to 5 persons in disabled motor boat.
6th.....	T. Knight, keeper, and C. Maloy, first assistant keeper, Hillsboro Light Station, Fla.	do.....	Assisted 2 men on board motor boat on rocks in Hillsboro Inlet, Fla., in getting boat off rocks and bringing her inside.
	T. Knight, keeper, Hillsboro Light Station, Fla.	Schooner Mary E. Suydam, of Pat-chogue, Long Island, N. Y.; F. A. Jofford, owner.	Assisted in supplying water, repairing rigging, and helping to get distressed vessel underway.
	A. F. Wichmann, keeper, L. R. Munn, second assistant keeper, Cape Romain Light Station, S. C.	Schooner Mary E. Suydam, of Pat-chogue, Long Island, N. Y.; F. A. Jofford, owner.	Rendered assistance to vessel aground off Cape Romain, remained with her until she floated, and furnished supplies.
	Tender Cypress.....	S. S. Mohawk, Clyde Steamship Co., New York, N. Y.	Recovered anchor and chain lost at entrance Charleston Harbor and delivered same to vessel's agent.
	C. P. Honeywell, keeper, Cape Canaveral Light Station, Fla.	Barge Louis H.; Taggart Coal Co., of Savannah, Ga., owners.	Assisted in caring for and keeping owners informed as to safety of barge left off station until tug returned.
	J. H. Carlin, keeper, and L. R. De Vaun, assistant, keeper, Brunswick Harbor Lights, Ga.		Rescued man from drowning in Brunswick Harbor, Ga.
	Tender Mangrove.....	Motor boat Dolphin, U. S. War Department.	Towed boat, disabled in Skull Creek, S. C., with company of soldiers and several officers aboard, to Fort Freemont, S. C.
	J. E. Swan, keeper, Mount Pleasant Rg. etc., Lights, S. C.	Motor boat.....	Furnished lodging and food to 2 men whose boat had sunk in Wando River, S. C.; recovered boat and towed it to Charleston, S. C.
	C. P. Honeywell, keeper, and O. F. Quarterman, second assistant keeper, Cape Canaveral Light Station, Fla.	Steamer Thames, of Wilmington, Del.	Answered distress signals and furnished transportation to mate and 1 seaman by launch to telephone and store where supplies were secured.
	Tender Water Lily.....	Motor boat, Catherine Davis, of Charleston, S. C.	Pulled excursion vessel with about 40 negroes on board off marsh, Dawho River, S. C.
	Tender Cypress.....	Hydroplane, U. S. Navy Department.	Picked up disabled hydroplane with 2 men about 10 miles southeast of Fowey Rocks Light Station, Fla.
	Tender Mangrove.....	Steamer Parismina; United Fruit Co., New York, N. Y., owners.	Assisted in pulling vessel off shoal in St. Johns River, Fla.
	Tender Cypress.....	S. S. Oak Branch....	Picked up anchor and chain lost off entrance to Charleston Harbor, S. C., and delivered same to vessel's agent, Charleston, S. C.
7th.....	Tender Ivy.....	Schooner Brazos....	Rescued 4 men on a raft, adrift at North Key Shoal, Fla.
	Tender Snowdrop.....	Sea Wolf.....	Rendered valuable assistance to launch Sea Wolf, which had struck a reef in the vicinity of Fowey Rocks Light Station, Fla.

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
8th.....	Tender Camellia.....	Quarantine Station, Galveston, Tex.	Assisted in extinguishing fire.
	Tender Sunflower.....	U. S. Engineer Department coaling station, South Pass, La.	Assisted in extinguishing fire.
	J. D. Bakillie, keeper, Galveston Harbor Lights, Tex.	Sloop Edna, Houston, Tex.	Rendered assistance to man in boat; put him under sail.
	G. W. Bardwell, keeper, and M. Durabb, assistant keeper, Galveston Jetty Light Station, Tex.	Launch Texas Jack..	Rendered assistance to man in launch blown ashore.
	R. F. Steen, keeper, Cat Island Light Station, Miss.	Schooner Olga M., of Biloxi, Miss.	Gave medical attention to helpless man in boat.
	Tender Camellia.....	Catboat Opel.....	Rescued 5 men from capsized boat and took them on board tender.
	R. F. Steen, keeper, Cat Island Light Station, Miss.	Motor boat Havana, of Biloxi, Miss.	Rescued 2 men in helpless condition and furnished them lodging and dry clothes.
	C. T. Thomassen, assistant keeper, Head of Passes Light Station, La.	.....	Assisted engineers in extinguishing fire which threatened to destroy Government property near Cypress Range Front Light, La.
	R. F. Steen, keeper, Cat Island Light Station, Miss.	Motor launch Jane...	Rendered assistance to 5 men in boat, adrift; furnished them food and clothing.
	R. F. Steen, keeper, Cat Island Light Station, Miss.	Oyster schooner Josephine Lopez, of Biloxi, Miss.	Assisted crew of grounded schooner and brought them to Pass Christian, Miss., in station launch.
	R. F. Steen, keeper, Cat Island Light Station, Miss.	Schooner Algonquin, of New Orleans, La.	Assisted crew of grounded schooner and brought them to Pass Christian, Miss., in station launch.
	G. R. Smith and L. F. Smith, keeper and assistant keeper, Red Fish Bar Cut Light Station, Tex.	Motor launch.....	Furnished man in disabled boat food and shelter.
	H. A. Succow, keeper, Pass Manchac Light Station, La.	Motor launch Joe Halley; Alfred Quillbear, owner.	Assisted man adrift in boat, and brought him to station.
	W. W. Bayly, keeper; M. W. Hamm, first assistant keeper; and B. S. Bayly, temporary laborer, Chandeleur Light Station, Miss.	.....	Maintained light and cared for Government property under adverse conditions during hurricane.
	E. Buras, laborer, Lighthouse Depot, Port Eads, La.	.....	Do.
	F. Hurd, keeper, Devils Point, etc., Lights, Fla.	.....	Maintained lights and cared for Government property under adverse conditions during hurricane.
	W. J. Doyle, keeper, Fort Barrancas Range Light Station, Fla.	.....	Do.
	J. W. St. G. Gibbon, keeper, and C. T. Thomassen, assistant keeper, Head of Passes Light Station, La.	.....	Do.
	A. E. Stelmer, keeper, and W. D. Elland, assistant keeper, Horn Island Light Station, Miss.	.....	Do.
	W. R. Thompson, keeper; R. L. Purcell, first assistant keeper; and H. H. Holdeman, second assistant keeper, Pensacola Light Station, Fla.	.....	Do.
	S. Gibbon, keeper, and W. F. Stephens, first assistant keeper, Sand Island Light Station, Ala.	.....	Do.
	L. F. Edgecombe, keeper, and S. Coludrovich, second assistant keeper, South Pass Range Rear Light Station, La.	.....	Do.
	J. B. Mason, keeper; J. W. Simmons, first assistant keeper; and A. Johnson, second assistant keeper, Southwest Pass Light Station, La.	.....	Do.
	Tender Magnolia.....	.....	Displayed excellent seamanship in proceeding to protected waters of Escambia Bay, where vessel rode out hurricane in safety.
	A. Shaw, Jr., keeper, Presque Isle Light Station, Pa.	Yacht Invader.....	Provided shelter, food, and clothing for 3 men when yacht was driven ashore.
10th.....			

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
10th.....	R. Allen, keeper, Presque Isle Pierhead Light Station, Pa. C. H. Tucker, keeper, Oswego Light Station, N. Y.	Fishing tug Gannet. Sailing yacht.....	Assisted in extinguishing fire. Assisted in rescue of man who had fallen overboard one-fourth mile from light station.
11th.....	Tender Crocus..... C. Jonas, keeper, Manitou Light Station, Mich. L. Clark, first assistant keeper, and L. Hudak, third assistant keeper, Spectacle Reef Light Station, Mich. K. Olson, keeper, and F. E. Fredrickson, first assistant keeper, Stannard Rock Light Station, Mich. C. E. Richardson, keeper, Round Island Light Station (St. Marys River), Mich. W. A. Burke, keeper, Saginaw River Range Light station, Mich. W. G. Jilbert, keeper, Mendota Light Station, Mich.	Steamer War Fox... Motor boat; Frank Hill, owner. Motor boat Mary M.. Motor boat..... U. S. patrol boat S. P. 309. Motor boat; Dr. A. M. Warren, owner. Motor boat.....	Assisted stranded steamer. Rescued disabled motor boat, with 5 occupants, drifting onto rocks during storm. Towed disabled boat to station. Towed disabled boat 8 miles to station. Assisted in repairing disabled boat. Released stranded boat and towed it to safety. Rendered assistance to 3 fishermen whose launch had swamped in a heavy sea in the vicinity of the station.
12th.....	O. H. Knudson, keeper, and H. Schleitf, first assistant keeper, Milwaukee Pierhead Light Station, Wis. C. S. Grenell, keeper, Chicago Pierhead Light Station, Ill. J. M. Robinson, keeper, Calumet Harbor Light Station, Ill. .....do..... C. W. Sanderson, keeper, Dunlap Reef Range Light Station, Wis. H. R. Bevery, keeper, and W. H. Nash, second assistant keeper, Wind Point Light Station, Wis. A. C. Erickson, keeper, Little Traverse Light Station, Mich. T. Robinson, keeper, Muskegon Light Station, Mich. R. W. Johnson, keeper, North Manitou Light Station, Mich. Tender Hyacinth..... C. E. Corlett, keeper, and W. Renier, assistant keeper, Manistique Light Station, Mich. C. J. Graan, keeper, Calumet Pierhead Light Station, Ill. F. A. Draw, keeper, Green Island Light Station, Wis. J. Napelzinski, keeper, and R. F. Wright, assistant keeper, Manitowoc Light Station, Wis. C. O. Butler, mechanician.....	Motor boat Dewey.. Gasoline launch Achaephall. Launch Bee, C. H. Larson, Chicago, owner. Sloop Dolphin; A. T. Lawrie, Milwaukee, Wis., owner. Cruiser Driad, of Racine, Wis. Tug Ida M. Stevens. Launch Teal..... Barge: Leathern & Smith, Sturgeon Bay, Wis., owners. Power boat Mary Ellen. Motor boat Maine...	Towed disabled motor boat to harbor. Assisted in rescuing a man who had fallen off the north pier. Towed launch, adrift with 2 people aboard, to station. Towed disabled and drifting launch to station. Rendered assistance to sloop in great danger of foundering. Rendered assistance to auxiliary cruiser grounded on reef. Rescued woman who had fallen into the water when getting out of a boat at dock. Rendered assistance to disabled tug and furnished dry clothing to 2 men on tug. Hauled launch, ashore north of fog-signal building, out of danger. Assisted in pulling barge off reef. Assisted district mechanician all day of each working day from Nov. 11 to 30, inclusive, besides standing their regular watches at night. Assisted in towing surfboat to the scene of the wreck of the power boat Mary Ellen. Towed disabled motor boat 3 miles.
15th.....	Tender Oleander.....	Barges, etc.....	Assisted in search for bodies of 2 young persons drowned in the Manitowoc River and recovered body of 1. Secured 62 members for Red Cross while on vacation. Floated and towed 7 coal-laden barges to place of safety from point on bar in midstream where fleet had grounded; rescued 6 barges, including 4 U. S. Engineer Department steel barges, and other vessels, from ice and towed to safe harbor; transported stores and supplies to grounded steamer, and towed disabled gas boat and log raft to safe harbor.

SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918—Continued.

District.	Vessel or employee rendering service.	Vessel, etc., aided.	Nature of assistance.
16th.....	Tender Kukul.....	Schooner Olympe..	Towed disabled schooner to safe anchorage.
	Edmund Moore, keeper; C. E. Schulze, first assistant; and E. Teeter, second assistant, Scotch Cap Light Station, Alaska.	Cargosteamer Kotohera Maru, Kobe, Japan; Gunsiro Katsuda, owner.	Rendered assistance to 12 shipwrecked men, landed in heavy surf, and furnished them shelter.
	D. O. Kinyon, keeper, Guard Island Light Station, Alaska.	Fishing boat Mayflower.	Towed disabled boat to Ketchikan.
	L. Amundsen, night watchman at Ketchikan Depot, Alaska; M. McDonough, seaman, Kukul.	Launch.....	Rescued 4-year-old boy who fell into deep water from Lighthouse Dock.
	R. McKlem, keeper, and W. A. Shoemaker, assistant keeper, Eldred Rock Light Station, Alaska.		Furnished food and shelter to 2 men from disabled launch; took them to Fort Seward, 18 miles distant, in station launch, leaving lighthouse keeper alone at station for 3 days in bad weather.
17th.....	Tenders Fern and Cedar.....	S. S. Mariposa, Alaska S. S. Co.	Rendered assistance to wrecked steamer; transported officers, crew, passengers, baggage, etc., to Wrangell; picked up man and wife and furnished them subsistence and transportation to Shaskan Bay Cannery, Alaska.
	B. B. Meagher, keeper, Smith Island Light Station, Wash.	Steamer Samson, Puget Sound Navigation Co.	Transported officer of disabled steamer by station boat, through rough sea, to get assistance.
	O. V. Brown, keeper, Browns Point Light Station, Wash.		Rescued 3 Japanese from drowning near light station and furnished them clothing.
18th.....	W. A. Beeman, keeper; M. Cady, first assistant; and M. M. Palmer, second assistant, Point Loma Light Station, Cal.	Fish boat Pacific B-1.	Assisted in saving boat's cargo of fish.
	Tender Sequoia.....	Silverado, Shipping Board vessel, loaned to Matson Navigation Co.	Picked up disabled steamer and assisted in towing it to shore.
	E. Wiborg, keeper, Trinidad Head Light Station, Cal.	Gasoline launch.....	Rescued man in disabled launch.

DAMAGE BY COLLISIONS.

During the fiscal year there were 25 cases of collisions by vessels with aids to navigation, tenders and other lighthouse property, causing damages which have been repaired or paid for by the parties responsible therefor, or proper measures taken by the Lighthouse Service to compel payment by owners of the vessels where such owners or vessels were identified.

During the fiscal year there were three cases of collisions, in which vessels of the Lighthouse Service were found to have been responsible for damage to other vessels, or property. Adjustment of claims resulting from these collisions, in the total amount of \$189.33 has been made and report submitted to Congress under the provisions of section 4 of the act of June 17, 1910 (36 Stat. 537).

PUBLICATIONS OF THE LIGHTHOUSE SERVICE.

[All publications are at present distributed free.]

Publications.	Date of last edition.	Cost of last edition.	Number distributed.
Light lists:			
Atlantic and Gulf coasts of United States.....	Jan. 1, 1918	\$4,295	10,538
Pacific coast of United States, etc.....	do.	813	2,341
Great Lakes of United States and Canada.....	Apr. 1, 1913	1,030	1,198
Upper Mississippi River and tributaries.....	Jan. 15, 1918	558	772
Ohio River and tributaries.....	Sept. 15, 1917	128	905
Lower Mississippi River and tributaries.....	Nov. 15, 1917	173	794
Buoy lists:			
First district.....	May 1, 1918	888	4,444
Second district.....	June 1, 1918	757	4,301
Third district.....	May 15, 1918	731	5,084
Fourth district.....	June 1, 1917	335	4,505
Fifth district.....	May 15, 1918	901	3,825

PUBLICATIONS OF THE LIGHTHOUSE SERVICE—Continued.

Publications.	Date of last edition.	Cost of last edition.	Number distributed.
Buoy lists—Continued.			
Sixth district.....	May 1, 1918	\$387	2,608
Seventh district.....	do.	474	2,745
Eighth district.....	Sept. 1, 1916	704	3,744
Ninth district.....	May 15, 1918	27	.....
Tenth district.....	Apr. 1, 1917	211	1,432
Eleventh district.....	do.	531	1,266
Twelfth district.....	do.	349	1,310
Sixteenth district.....	June 1, 1918	262	452
Seventeenth district.....	do.	468	907
Eighteenth district.....	do.	229	919
Nineteenth district.....	Apr. 1, 1918	20	20
Miscellaneous publications:			
Weekly Notice to Mariners.....	1918	3,051	226,960
Annual Report, Commissioner of Lighthouses.....	1917	805	1,484
Regulations for the United States Lighthouse Service.....	1918	619	447
Medical handbook.....	1915	633	66
Lighthouse Service bulletins.....	1918	229	18,000
Regulations for lighting bridges.....	1915	202	206
Regulations for uniforms.....	1912	70	28
Civil-service regulations.....	1913	73	82
Instructions for cost keeping.....	1914	120	35
Instructions to employees.....	1915	408	47
The United States Lighthouse Service.....	1915	508	63

COST OF PRINTING FOR THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1918.

Light lists.....	\$7,295.53
Buoy lists.....	6,483.79
Notices to mariners.....	3,128.64
Annual report.....	604.55
Specifications and other publications.....	968.46
Forms, reports, record books, etc.....	6,385.81
Total.....	24,866.78

The following amounts were received by the Lighthouse Service during the year and turned into the Treasury: From sales of property, \$14,956.55; from damages to aids to navigation and other property, \$4,485.77; from leases and rentals, \$5,434.50.

APPROPRIATIONS FOR THE BUREAU OF LIGHTHOUSES AND THE LIGHTHOUSE SERVICE, SIXTY-FIFTH CONGRESS, FIRST AND SECOND SESSIONS, 1917-18.

Title	Act.	Amount.
Maintenance:		
Salaries, Bureau of Lighthouses, 1919.....	Legislative, July 3, 1918.....	\$65,430
General expenses, Lighthouse Service, 1919.....	Sundry civil, July 1, 1918.....	3,500,000
Salaries of keepers of lighthouses, 1919.....	do.....	940,000
Salaries, lighthouse vessels, 1919.....	do.....	1,265,000
Salaries, Lighthouse Service, 1919.....	do.....	380,000
Total for maintenance.....		6,150,430
Special works:		
Nantucket Harbor Fog Signal, Mass.....	Urgent deficiency, Mar. 28, 1918.....	15,000
Staten Island Lighthouse Depot, N. Y. (wharves).....	do.....	60,000
Repairing and rebuilding aids to navigation, Gulf of Mexico.....	do.....	100,000
Repairing and rebuilding aids to navigation, Atlantic coast.....	do.....	150,000
Aids to navigation, Guantanamo Bay, Cuba.....	Sundry civil, July 1, 1918.....	14,000
Depot for second lighthouse district.....	do.....	85,000
Detroit Lighthouse Depot, Mich.....	do.....	53,000
Sand Island Light Station, Ala.....	do.....	37,000
Spectacle Reef Light Station, Mich.....	do.....	28,000
Ambrose Channel Lighted Buoys, N. J.....	do.....	26,000
Fifth lighthouse district, gas buoys.....	do.....	65,000
Depot for sixteenth lighthouse district.....	do.....	90,000
Total for special works.....		723,000
Grand total.....		6,873,430

EXPENDITURES DURING THE FISCAL YEAR 1918 FROM APPROPRIATIONS FOR THE LIGHTHOUSE SERVICE.

(Obligations incurred are not included.)

Salaries:	
Bureau of Lighthouses, 1917.....	\$2, 632. 15
Bureau of Lighthouses, 1918.....	57, 044. 64
Salaries of keepers of lighthouses:	
1917.....	93, 570. 66
1918.....	909, 487. 55
Salaries, lighthouse vessels:	
1917.....	125, 511. 24
1918.....	1, 180, 901. 65
Salaries, Lighthouse Service:	
1917.....	4, 142. 58
1918.....	362, 789. 94
General expenses, Lighthouse Service:	
1916.....	217, 232. 52
1917.....	834, 490. 06
1918.....	2, 467, 450. 46
Total maintenance.....	6, 255, 253. 45

SPECIAL WORKS.

General:	
Repairing and rebuilding aids to navigation, Atlantic coast.....	29, 647. 74
Tender for first lighthouse district.....	2, 968. 90
Light vessels for general Lake service.....	112. 22
Light vessels for general service.....	6, 938. 28
Lighthouse tender, general service.....	59, 446. 08
Radio installations on lighthouse tenders.....	23. 12
Oil houses for light stations.....	12. 55
Claims for damages by collision with lighthouse vessels.....	181. 38
Second district:	
Cape Cod Canal Lights, Mass.....	2, 176. 58
Woods Hole Lighthouse Depot, Mass.....	14, 586. 82
Third district:	
Staten Island Lighthouse Depot, N. Y. (office).....	10. 04
Staten Island Lighthouse Depot, N. Y. (wharves).....	12. 54
Aids to navigation, Hudson River, N. Y.....	1, 995. 98
Aids to navigation, East River, N. Y.....	1, 326. 00
Tender for third lighthouse district.....	72. 37
Fourth district:	
Aids to navigation, Delaware River, Pa. and Del.....	34, 169. 93
Fifth district:	
Thimble Shoal Light Station, Va.....	3, 867. 64
Lighting Norfolk Harbor, Va.....	1, 720. 00
Aids to navigation, Chesapeake Bay, Md. and Va.....	1, 201. 80
Sixth district:	
Tender for engineer, sixth lighthouse district.....	2, 338. 01
Aids to navigation, St. Johns River, Fla.....	13, 606. 34
Seventh district:	
Aids to navigation, Florida Reefs, Fla.....	2, 300. 56
Eighth district:	
Aransas Pass Light Station, Tex.....	5. 75
Galveston Jetty Light Station, Tex.....	51. 95
Southwest Pass Light Vessel, Mississippi River, La.....	521. 70
Aids to navigation, Atchafalaya Entrance Channel, La.....	5, 757. 92
Repairing and rebuilding aids to navigation, Gulf of Mexico.....	110, 399. 23
Ninth district:	
Navassa Island Light Station, West Indies.....	2, 291. 38
Tenth district:	
Aids to navigation, Ashtabula Harbor, Ohio.....	1, 070. 88
Aids to navigation, Lorain Harbor, Ohio.....	891. 73
Aids to navigation, Conneaut Harbor, Ohio.....	23, 461. 50
Aids to navigation, Toledo Harbor, Ohio.....	13, 085. 31
Aids to navigation, Fairport Harbor, Ohio.....	400. 00
Aids to navigation, Huron Harbor, Ohio.....	11. 84

Eleventh district:

Aids to navigation, Fighting Island Channel, Detroit River, Mich.	\$8,686.46
Detroit River Lights, Mich.	5,825.00
Superior Pierhead Range Lights, Wis.	1,193.82
Aids to navigation, Ashland, Wis.	56.20
Sand Hills Light Station, Mich.	29,941.08
Aids to navigation, Keweenaw Waterway, Mich.	15,579.69

Twelfth district:

White Shoal Light Station, Lake Michigan	780.00
Chicago Harbor Light Station, Ill.	55,037.14
Manitowoc Breakwater Light Station, Wis.	964.23
Aids to navigation, Indiana Harbor, Ind.	28.00

Sixteenth district:

Aids to navigation, Alaska	39,674.38
Cape St. Elias Light Station, Alaska	907.02

Seventeenth district:

Aids to navigation, Puget Sound, Wash.	8,671.73
Kellett Bluff Light Station, Wash.	2,220.30
Aids to navigation, Wash. and Oreg.	4,438.81

Nineteenth district:

Aids to navigation, Pearl Harbor, Hawaii	11,620.44
------------------------------------------	-----------

Total, special works..... 522,288.37

Total, maintenance appropriations..... 6,255,253.45

Total, special works..... 522,288.37

Grand total..... 6,777,541.82

ITEMIZED ESTIMATES OF APPROPRIATIONS FOR THE FISCAL YEAR 1920, AND ITEMIZED STATEMENT OF EXPENDITURES FOR THE FISCAL YEAR 1918, AS REQUIRED BY THE ACT OF CONGRESS APPROVED JUNE 25, 1910 (36 STAT., 755).

[The expenditures herein stated are in part estimated, owing to the fact that all obligations incurred for the year 1918 have not yet been settled. Articles of supplies purchased for general stock have also been distributed, approximately, to features to be benefited. This table refers to appropriations made in the sundry civil appropriation act and does not include Bureau salaries in Washington nor the cost of publications, otherwise provided for. This statement contains also amounts for salaries and wages under certain items which are shown separately in the Book of Estimates, 1920.]

Item.	Estimate, 1920.	Expenditures, 1918.	Item.	Estimate, 1920.	Expenditures, 1918.
GENERAL EXPENSES, LIGHTHOUSE SERVICE.			GENERAL EXPENSES, LIGHTHOUSE SERVICE—continued.		
Lights and fog signals:			Buoys:		
Rations and provisions.....	\$247,700	\$156,862	Establishment.....	\$145,000	\$118,722
Fuel and rent for keepers....	79,000	63,889	Supplies.....	33,000	27,104
General supplies.....	206,000	237,559	Repairs.....	39,500	68,101
Repairs and improvements, including grounds and outbuildings.....	234,200	246,267	Incidental expenses.....	2,000	1,757
Establishing lights and fog signals, including sites.....	29,000	20,010	Tenders:		
Necessary additional land for light stations.....	1,500	.....	Rations and provisions.....	292,000	235,590
Oil and carbide houses.....	1,550	7	Supplies.....	575,000	460,762
Incidental expenses.....	12,500	10,001	Repairs.....	757,500	264,673
Daymarks and spindles:			Incidental expenses.....	9,000	7,726
Establishment, including sites.....	2,000	2,209	Light vessels:		
Repairs and improvements.....	7,100	4,932	Rations and provisions.....	157,000	117,338
Incidental expenses.....	200	.....	Supplies.....	165,000	132,788
Port lights:			Repairs.....	247,200	124,332
Establishment.....	2,000	2,237	Incidental expenses.....	3,008	2,461
Wages of laborers attending lights.....	268,600	242,807	Depots:		
Supplies.....	27,000	21,880	Pay of laborers and mechanics.....	90,000	71,100
Repairs and improvements.....	27,500	19,482	Rent.....	5,000	5,120
Incidental expenses.....	250	171	Repairs and improvements.....	157,500	145,229
			Incidental expenses.....	17,000	13,829
			Offices:		
			Technical books and periodicals.....	500	264

ITEMIZED ESTIMATES OF APPROPRIATIONS FOR THE FISCAL YEAR 1920, AND ITEMIZED STATEMENT OF EXPENDITURES FOR THE FISCAL YEAR 1918—Continued.

Item.	Estimate, 1920.	Expenditures, 1918.	Item.	Estimate, 1920.	Expenditures, 1918.
GENERAL EXPENSES, LIGHTHOUSE SERVICE—continued.			SALARIES, LIGHTHOUSE VESSELS.		
Offices—Continued.			Salaries and wages, lighthouse tenders.....	\$1,201,800	\$763,139
Stationery and office supplies.....	\$13,000	\$10,631	Salaries and wages, light vessels.....	678,200	417,677
Telegraph and telephone.....	6,000	6,112	Total.....	1,880,000	1,180,827
Traveling expenses and mileage.....	26,000	21,024	Appropriation, 1919, \$1,265,000.		
Rent.....	3,000	2,714	Appropriation, 1918, \$1,104,650.		
Freight, expressage, and cartage.....	18,000	14,596	SALARIES, LIGHTHOUSE SERVICE.		
Incidental expenses.....	3,000	2,466	Salaries, executive and technical.....	154,900	134,100
Total.....	4,000,000	2,882,751	Salaries, clerical and messenger.....	164,340	140,654
Appropriation, 1919, \$3,500,000.			Salaries, authorized depot force.....	113,760	88,300
Appropriation, 1918, \$2,850,000.			Total.....	433,000	363,054
SALARIES OF KEEPERS OF LIGHTHOUSES.			Appropriation, 1919, \$380,000.		
Salaries of lighthouse keepers.....	1,321,600	909,490	Appropriation, 1918, \$380,000.		
Appropriation, 1919, \$940,000.					
Appropriation, 1918, \$940,000.					

NOTE.—The expenditures shown include reimbursements from Navy Department for part of maintenance expenses of vessels and stations transferred temporarily to Navy by Executive order. Under appropriation "General expenses, Lighthouse Service," it is proposed during the fiscal year 1919 to authorize per diem in lieu of subsistence, pursuant to the act of August 1, 1914, at rates of from \$2 to \$4.

SUMMARY OF ESTIMATES OF APPROPRIATIONS FOR THE LIGHTHOUSE SERVICE FOR THE FISCAL YEAR 1920.**FOR GENERAL MAINTENANCE OF THE LIGHTHOUSE SERVICE.**

Salaries, Bureau of Lighthouses.....	\$69,030
General expenses, Lighthouse Service.....	4,000,000
Salaries, Lighthouse Service.....	433,000
Salaries, keepers of lighthouses.....	1,321,600
Salaries, lighthouse vessels.....	1,880,000
Retired pay, Lighthouse Service.....	50,000
Total.....	7,753,630

FOR SPECIAL WORKS.

Group 1. Works urgently necessary for the safety or immediate needs of navigation and for the preservation of existing structures or equipment, for the full utilization of other public improvements, or for the efficient equipment of the Lighthouse Service:

1. Constructing or purchasing and equipping tenders and light-vessels.....	760,000
2. Hawaiian Islands Lighthouse Depot, construction and equipment.....	120,000
3. Light-keepers' dwellings, construction.....	75,000
4. Lighthouse depot for fifth district, enlargement, improvement, or establishment of new depot.....	275,000
5. St. Marys River, Mich., aids to navigation.....	80,000
6. Staten Island Lighthouse Depot, N. Y., improvements.....	45,000
7. Virgin Islands, West Indies, aids to navigation.....	50,000
8. Staten Island Lighthouse Depot, N. Y., improvement and extension of wharves.....	65,000
9. Potomac River, Md., aids to navigation.....	95,000
10. Lighthouse depot for eighth district, construction.....	88,500

NOTE.—All of the foregoing items have been authorized by law, wholly or in part.

Group 1. Works urgently necessary for the safety or immediate needs of navigation and for the preservation of existing structures or equipment, for the full utilization of other public improvements, or for the efficient equipment of the Lighthouse Service—Continued.

11. Riprap, etc., for 39 light stations, third district.....	\$284, 000
12. Charleston Lighthouse Depot, S. C., improvements.....	115, 000
13. Lighthouse depot for seventh district, establishing.....	200, 000
14. Alaska, establishing new aids and improving existing aids.....	75, 000
15. Ludington, Mich., aids to navigation.....	50, 000
16. Tampa Bay, Fla., aids to navigation.....	17, 500
17. Delaware Bay entrance, improvement of aids to navigation.....	148, 500
18. Goose Island Flats, N. J., establishment of light and fog signal station.....	140, 000
19. California and Nevada, aids to navigation.....	37, 775
20. Goat Island Lighthouse Depot, Cal., improvement.....	16, 500
Authorized by law.....	\$1, 608, 500
Not authorized.....	1, 129, 275

Total, group 1.....	2, 737, 775
---------------------	-------------

Group 2. Works considered essential for the needs of navigation and the equipment of the Lighthouse Service, and which it is recommended be undertaken as resources permit, are submitted with estimates of cost. (These items have been selected from a much larger number of recommendations submitted by the superintendents of the lighthouse districts and others.)

21. Point Pinos Light Station, Cal., improvement.....	37, 500
22. Michigan Island, Wis., establishment of light and fog-signal station.....	85, 000
23. Kauhola Point Light Station, Hawaii, improvement.....	20, 000
24. Anacapa Island, Cal., establishment of light and fog-signal station.....	115, 000
25. Santa Barbara Light Station, Cal., improvements.....	33, 000
26. Cape Spencer, Alaska, establishment of light and fog-signal station.....	145, 000
27. Staten Island Lighthouse Depot, N. Y., dry dock.....	200, 000
28. Portage Lake, Mich., establishment of light and fog-signal station and improvement of aids.....	100, 000
29. Ram Island, Me., establishment of light.....	5, 400
30. Cape Kumukahi, Hawaii, establishment of light.....	22, 000
31. Henderson Point, Me., establishment of light and fog signal.....	7, 500
32. Port Real, P. R., establishment of light station.....	40, 000
33. Nine Mile Point, Mich., establishment of light and fog-signal station.....	50, 000
34. Caribbean Sea, aids to navigation ^a	75, 000
35. Galveston Jetty Light Station, Tex., improvements.....	8, 500
36. Grays Harbor Light Station, Wash., improvements.....	15, 000
37. Newport, R. I., or vicinity, depot, etc.....	82, 300
38. Lake Champlain, N. Y. and Vt., improvements.....	150, 000
39. Sag Harbor, N. Y., improvements.....	45, 700
40. Manitowoc, Wis., improvements.....	16, 000
41. Alaska, improvements.....	70, 000

Total, group 2 (not included in total of estimates).....	1, 322, 900
----------------------------------------------------------	-------------

RECAPITULATION.

For general maintenance of the Lighthouse Service.....	7, 753, 630
For special works: Group 1.....	2, 737, 775
Total.....	10, 491, 405

^a Upon the recommendation of the Secretary of Commerce an allotment of \$100,000 has been made by the President, from the appropriation for national security and defense, for the project covered by Item No. 34.

DETAILED ESTIMATES FOR MAINTENANCE, 1920.

BUREAU OF LIGHTHOUSES.

Salaries..... \$69,030

GENERAL EXPENSES, LIGHTHOUSE SERVICE.

For supplies, repairs, maintenance, and incidental expenses of lighthouses and other lights, beacons, buoyage, fog signals, lighting of rivers heretofore authorized to be lighted, light vessels, other aids to navigation, and lighthouse tenders, including the establishment, repair, and improvement of beacons and day marks and purchase of land for same; the establishment of post lights, buoys, submarine signals, and fog signals; the establishment of oil or carbide houses not to exceed \$10,000: *Provided*, That any oil or carbide house erected hereunder shall not exceed \$550 in cost; the construction of necessary outbuildings at a cost not exceeding \$500 at any one light station in any fiscal year; the improvements of grounds and buildings connected with light stations and depots; restoring light stations and depots and buildings connected therewith: *Provided*, That such restoration shall be limited to the original purpose of the structures; wages of laborers attending post lights; pay of temporary employees and field force while engaged on works of general repair and maintenance and pay of laborers and mechanics at lighthouse depots; rations and provisions or commutation thereof for keepers of lighthouses, working parties in the field, officers and crews of light vessels and tenders, and officials and other authorized persons of the Lighthouse Service on duty on board of such tenders or vessels; and money accruing from commutation for rations and provisions for the above-named persons on board of tenders and light vessels or in working parties in the field may be paid on proper vouchers to the person having charge of the mess of such vessel or party, reimbursement under rules prescribed by the Secretary of Commerce of keepers of light stations and masters of light vessels and of lighthouse tenders for rations and provisions and clothing furnished shipwrecked persons who may be temporarily provided for by them, not exceeding in all \$5,000 in any fiscal year; fuel and rent of quarters where necessary for keepers of lighthouses; the purchase of land sites for fog signals; the rent of necessary ground for all such lights and beacons as are for temporary use or to mark changeable channels and which in consequence can not be made permanent; the rent of offices, depots, and wharves; traveling expenses, mileage, library books for light stations and vessels, and technical books and periodicals not exceeding \$1,000; traveling and subsistence expenses of teachers while actually employed by States or private persons to instruct the children of keepers of lighthouses; and for all other contingent expenses of district offices and depots and not exceeding \$8,500 for contingent expenses of the Office of the Bureau of Lighthouses in Washington, \$4,000,000.

NOTE.—The amount estimated for is \$500,000 in excess of the appropriation for the fiscal year 1919, made necessary on account of the general expansion of the Service and the great advance in the cost of all commodities and services.

An increase of appropriation is considered necessary on account of the increase in numbers of aids required for the safety of navigation, to keep the Lighthouse Service in an economical state of repair and efficiency, and because of the recent extraordinary advance in the price of labor and materials. The total number of aids was increased in 1918 from 15,227 to 15,673, an increase of 446, or 2.9 per cent. In order to keep pace with the constant development of commerce it is believed that proper provision for maintenance and repair as well as for the establishment of necessary additional minor aids frequently requested by mariners should be made. With the increasing numbers of requests for aids, it is impossible to render the full efficiency and service demanded unless adequate provision is made for funds. It has been found necessary to estimate on a 30 per cent increase for all items in the appropriations covering the purchase of supplies and materials, due to the continued steady general advance in prices. It is, therefore, believed that the additional amount requested is conservative in view of the circumstances.

SALARIES, KEEPERS OF LIGHTHOUSES.

For salaries of not exceeding 1,800 lighthouse and fog-signal keepers and laborer attending lights, exclusive of post lights, \$1,321,600.

NOTE.—The foregoing estimates of appropriation call for an increase of \$331,600 over the appropriation of \$940,000 made for this purpose for the fiscal year 1919, and is based on the increase authorized by act of June 20, 1918, which provided for an average salary of \$340 for keepers of lighthouses.

(See p. 618 for itemized estimate.)

SALARIES, LIGHTHOUSE VESSELS.

For salaries and wages of officers and crews of light vessels and lighthouse tenders, including temporary employment when necessary, \$1,880,000.

NOTE.—The amount estimated for is \$615,000 in excess of the appropriation for the fiscal year 1919, and is caused by the unprecedented situation in shipping conditions, making it quite impossible to obtain seamen, firemen, cooks, etc., at the former recognized standard rates of pay. The foregoing estimate is based on standard pay schedules now followed on the various coasts. A further and fuller statement of this situation is found in this report at p. 853.

(See p. 618 for itemized estimate.)

SALARIES, LIGHTHOUSE SERVICE.

For salaries of 17 lighthouse superintendents, and of clerks and other authorized permanent employees in the district offices and depots of the Lighthouse Service, exclusive of those regularly employed in the office of the Bureau of Lighthouses, Washington, D. C., \$433,000.

NOTE.—An increase of \$53,000 over the appropriation for the fiscal year 1919 is submitted, consisting of the following:

To pay the increase in the compensation of superintendents of lighthouses, authorized by act of June 20, 1918, 16 superintendents, at \$600.....	\$9,600
Additional employees (2 clerks, 1 assistant superintendent, 2 watchmen, and 1 assistant depot keeper).....	7,000
Proposed increases in the pay of technical and clerical employees, especially the lower-paid positions, in order to meet the general advance in compensation.....	36,400
Total.....	53,000

The item of \$7,000 is occasioned by the general growth of the service in order that work of the districts may be dispatched promptly.

RETIRED PAY, LIGHTHOUSE SERVICE.

For retired pay of officers and employees, Lighthouse Service, \$50,000.

NOTE.—The act of June 20, 1918, provides, "That hereafter all officers and employees engaged in the field service or on vessels of the Lighthouse Service, except persons continuously employed in district offices or shops, who shall have reached the age of sixty-five years, after having been thirty years in the active service of the Government, may at their option be retired from further performance of duty; and all such officers and employees who shall have reached the age of seventy years shall be compulsorily retired from further performance of duty: *Provided*, That the annual compensation of persons so retired shall be a sum equal to one-fortieth of the average annual pay received for the last five years of service for each year of active service in the Lighthouse Service or in a department or branch of the Government having a retirement system, not to exceed in any case thirty-fortieths of such average annual pay received: *Provided further*, That such retirement pay shall not include any amount on account of subsistence or other allowance."

There are 102 persons in the Lighthouse Service over 70 years of age embraced in the above act, whose retirement pay totals \$37,640.28, and 34 persons entitled to optional retirement whose total retirement pay amounts to \$29,628.21. The amount estimated for the fiscal year 1920 is based on the full retired pay of persons over 70 years of age, and an estimated amount of \$12,359.72 for persons entitled to optional retirement and desiring same, and for additional persons who will reach the compulsory retirement age during the year for which the estimate is submitted.

DETAILED ESTIMATES FOR SPECIAL WORKS, 1920.

GROUP No. 1.

Works urgently necessary for the safety or immediate needs of navigation and for the preservation of existing structures or equipment, for the full utilization of other public improvements, or for the efficient equipment of the Lighthouse Service.

No. 1. *Tenders and light vessels for third, fifth, and eighth lighthouse districts, or in the Lighthouse Service generally.*—For constructing or purchasing and equipping lighthouse tenders, to replace those worn out in service, in the third and fifth lighthouse

districts, and a light vessel for the eighth lighthouse district, or in the Lighthouse Service generally, \$760,000.

NOTE.—The act of June 20, 1918, authorized \$760,000 for these vessels, but no appropriation has been made therefor. There are two tenders in the third and two in the fifth district, namely, the *John Rodgers*, *Mistletoe*, *Jessamine*, and *Holly*, that are old and of obsolete type, and should be replaced as soon as practicable by modern, efficient vessels. These tenders, to be kept in commission, require repairs that are not warranted by their age, condition, and the service obtained from them.

There is urgent need of a light vessel at South Pass, Gulf Coast, La., similar to the light vessel at Southwest Pass, as both passes are open and in use by mariners.

No. 2. *Hawaiian Islands Lighthouse Depot*.—For constructing and equipping a lighthouse depot at Honolulu, Hawaii, \$120,000.

NOTE.—The act of August 28, 1916 (39 Stat., 538), authorized \$90,000 for this work, but no appropriation was made therefor. The greatest need in this district is an adequate lighthouse depot. At present the stores are kept in two small, overcrowded, leaky storerooms on the Channel Wharf, Honolulu, where they are in danger of fire on account of proximity to fishing sampans, which are careless in the handling of gasoline. The heavy stores are kept in a large room adjoining the storage rooms occupied as a depot on Channel Wharf, lately vacated by the Territory because of the condemnation of the wharf. Buoys are kept some on Channel Wharf and some on War Department Wharf No. 1. The heavier buoys can not be kept on the Channel Wharf on account of its dilapidated condition, and when placed on the dock are exposed to the weather, and are frequently covered with coal when warships are coaling. In assembling materials for any construction work it has been the custom to collect them at the Channel Wharf, and if there is any considerable amount that wharf becomes filled up, necessitating the removal of the material on account of inconvenience to other users. Hence, the lack of a depot results in much inefficiency in collecting materials as well as inconvenience and annoyance. The fact that the temporary wharf and storehouse are in a bad state of repair, having been condemned some years ago, makes the situation very uncertain and unsatisfactory.

It is proposed to erect adequate buildings and improvements on this site for lighthouse depot purposes. The increase in the estimate over the amount authorized by act of August 28, 1916, is due to the great advance in materials and labor since that date. Detailed estimate:

Improvements and enlargement of wharf.....	\$40,000
General storehouse.....	32,250
Buoy wharf, Sand Island.....	10,800
Oil house.....	1,800
Buoy repair and carpenter shop sheds.....	3,900
Improvement of grounds, including walks, fences, etc.....	1,350
Machine and blacksmith shop.....	8,600
Shop equipment, etc.....	6,000
Keeper's dwelling.....	4,500
Buoy shed, Sand Island.....	10,800
Total.....	120,000

No. 3. *Light-keepers' dwellings*.—For light-keepers' dwellings and appurtenant structures, including sites therefor, within the limit of cost fixed by act approved February 26, 1907 (34 Stat., 996), \$75,000.

NOTE.—The act of August 28, 1916 (39 Stat., 537), authorized this work, but no appropriation was made therefor. The appropriations made March 4, 1907 (34 Stat., 1319), and May 27, 1908 (35 Stat., 334), of \$75,000 each, are now exhausted, but dwellings at a number of stations are yet needed, among which may be stated: Amelia Island, Fla.; Ano Nuevo Island, Cal.; Buffalo Breakwater, N. Y.; Charlotte, N. Y.; Diamond Head, Hawaii; Dry Tortugas, Fla.; Frankfort, Mich.; Ludington Breakwater, Mich.; Oswego Breakwater, N. Y.; Piedras Blancas, Cal.; Point Hueneme, Cal.; Point Montara, Cal.; Point Sur, Cal.; Port Eads, La.; Port San Juan, P. R.; Poverty Island, Mich.; Robinson Point, Wash.; Sand Island, Ala.; Tawas, Mich.; Toledo Harbor, Ohio; Two Harbors, Minn.; Cove Point, Md.; Point Lookout, Md.; Bodie Island, N. C.; Point Jiguero, P. R.; Wingo Neck, Buzzards Bay, Mass. Detailed estimate:

16 dwellings, at \$4,500.....	\$72,000
Contingencies.....	3,000
Total.....	75,000

No. 4. *Depot for fifth lighthouse district*.—For enlarging and improving the lighthouse depot at Portsmouth, Va., in the fifth lighthouse district, or for establishing a new depot, \$275,000.

NOTE.—The act of June 20, 1918, authorized this work, but no appropriation was made therefor. The present lighthouse depot at Portsmouth, Va., is entirely inadequate to the needs of the fifth district, both in area and in water front. This is the principal depot of one of the largest lighthouse districts and is the headquarters for five tenders and two light vessels during the greater part of the year. The aggregate length of these vessels is over 1,000 feet; the total wharf frontage is only 445 feet, of which over 200 feet is in a narrow slip available for small light-draft vessels only. The operation of tenders is much hampered by this limited frontage, the delay caused by waiting to discharge or receive cargo being estimated to cost the Lighthouse Service not less than \$25,000 a year; and now that the tenders are under the jurisdiction of the Navy Department, increased facilities are an urgent military necessity. The very small area available for buoy storage necessitates much otherwise unnecessary handling of heavy buoys and appendages at large cost of time and money. The available wharf frontage of this depot should be doubled, and the area increased by from 4 to 6 acres. This may be done by purchase of a new and larger site, or by purchase of adjacent property. The present buildings are mainly antiquated wooden structures. They constitute a fire menace and should be replaced by modern fireproof buildings. Detailed estimate:

Purchase of water-front property.....	\$125,000
Construction of wharf.....	53,700
Filling, grading, and paving.....	41,250
Storehouse, coal shed, machine, blacksmith, and carpenter shops.....	32,000
Water mains, fire-protection system, and traveling electric crane.....	8,900
Lighting system and generating plant.....	5,150

Buoy skids and chain platform.....	\$4, 000
Miscellaneous equipment.....	5, 000
Total.....	275, 000

No. 5. *St. Marys River, Mich., aids to navigation.*—For improving and repairing existing aids to navigation and for establishing and moving aids as required to best serve the needs of navigation in St. Marys River, Mich., and vicinity, \$80,000.

NOTE.—The act of June 20, 1918, authorized this work, but no appropriation was made therefor. To properly mark the main channel through the St. Marys River between Detour and Point Iroquois, lights are maintained on some 71 distinct structures, exclusive of floating aids. Forty-five of these structures are on submarine sites, completely surrounded by water and subject to great damage by ice action at the opening of navigation each season. During the past two seasons six structures have been completely destroyed by the ice and two more so badly damaged as to require complete reconstruction. In addition, many more have been damaged to so great an extent as to make a large expenditure necessary for their proper repair. These latter structures are in such condition as to make their complete destruction probable unless repairs are made at a very early date. This work of reconstruction and repair should be undertaken at once, and in addition there are numerous improvements to aids in this locality that will materially add to their effectiveness and in many cases result in a considerable saving in maintenance cost that should be carried out at the same time that general repairs, etc., are made. This is one of the most important sections of the Great Lakes waterway, and it is essential that the aids to navigation be maintained in the highest possible state of efficiency. Estimate of cost:

Repairs to foundations of existing structures.....	\$33, 500
Repairs and renewals to superstructures of existing structures.....	10, 400
New buoys.....	7, 500
New establishments and relocation of existing aids.....	10, 700
Improvements to illuminating apparatus.....	17, 900

Total..... 80, 000

No. 6. *Staten Island Lighthouse Depot, N. Y.*—For extending and enlarging the machine shop at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., \$45,000.

NOTE.—The act of June 20, 1918, authorized \$30,000 for this work, but no appropriation was made therefor. The present machine shop is so constructed as to be unadaptable for the work to be done in it. It will have to be extended and enlarged before it can be made an efficient and economical shop. The interior is divided into small narrow rooms, one story high, so that it is impossible to install any large machinery or a traveling crane, making it necessary to handle all work by hand. The windows are small and so arranged that the shop is dark in practically all parts except close to them. Moreover, the general construction is such that it is almost impracticable and very uneconomical to rearrange the old shop so as to be in any way convenient or efficient. The proposed improvements include an extension on the west side, three stories high, with windows properly located, having a large open room without partitions, the center of the second floor to be omitted to permit installation of traveling cranes for handling all heavy machinery, and the first floor to be so arranged that heavy machinery can be installed in such positions as to be accessible to the cranes. With this extension completed, the old shop can be used as a storehouse for casting metals, etc., which are used in connection with the machine-shop work, these being now stored in a separate building, which is an inconvenient and uneconomical arrangement. This will also release storage space for other supplies, which is badly needed. The increase in the estimate is due to the great advance in the cost of materials and labor since the original estimate was submitted. Detailed estimate:

Alterations to present shop.....	\$5, 500
New addition.....	39, 500

Total..... 45, 000

No. 7. *Virgin Islands, West Indies, aids to navigation.*—For establishing and improving aids to navigation in the Virgin Islands of the United States, West Indies, and adjacent waters, \$50,000.

NOTE.—The act of June 20, 1918, authorized this work, but no appropriation was made therefor. By Executive order of July 20, 1917, the lighthouse service in the Virgin Islands, West Indies, acquired by the United States by treaty from Denmark, was transferred to and placed under the jurisdiction of the United States Lighthouse Service. The aids to navigation in these islands are not extensive and will require additions and improvements to make the waters safe and to provide for increasing commerce. It is proposed to provide four unwatched gas lights, five new buoys, as well as additional aids as may be necessary after further study and developments, and to place existing lighthouse property in a good condition of repair. Detailed estimate:

4 unwatched lights.....	\$20, 000
5 buoys with moorings.....	5, 000
Relief and spare equipment for lights and buoys.....	5, 000
Repairs to existing property.....	10, 000
Additional aids to navigation, as necessary.....	10, 000

Total..... 50, 000

No. 8. *Staten Island Lighthouse Depot, N. Y.*—For improving and extending the wharves at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., \$65,000.

NOTE.—The act of June 20, 1918, authorized this work, but no appropriation was made therefor. The wharves at the general lighthouse depot are in a very poor condition and need extensive repairs. The traffic over the wharves is heavy, and it is necessary to be continually making temporary repairs. To continue the use of the wharves by means of temporary repairs will be expensive. It is advisable to repair and rebuild the wharves as soon as practicable. The present wharf space is limited and the wharves should be extended. There are 21 vessels in the third district (7 tenders and 14 light vessels) which use the general depot wharves, besides a considerable use by vessels of the Navy Department and commercial ships. Detailed estimate:

New wharf.....	\$65, 000
----------------	-----------

No. 9. *Potomac River, Md., aids to navigation.*—For improving the aids to navigation and establishing new aids on the Potomac River, Md., \$95,000.

NOTE.—The act of June 20, 1918, authorized this work, but no appropriation was made therefor. The Potomac River, from Maryland Point to Washington, about 40 nautical miles, is now lighted only by 4 gas buoys, 5 minor lights, and 1 lighthouse. The gas buoys are of low candlepower and are of necessity removed from station for several months in winter on account of ice conditions. The minor lights are all fixed white or red lights of low candlepower, located on wharves or on timber structures, which are liable to destruction by ice in winter. Jones Point Light Station is of little use on account of changes in shoreline at this point. It is proposed to establish 8 sets of flashing acetylene range lights and 7 or more flashing acetylene single lights, and to replace 15 of the present spar buoys by tall nun buoys more readily picked up at night. Jones Point Light Station and the 5 minor lights above mentioned may then be discontinued. Detailed estimate:

Purchase of sites for 8 lights.....	\$12,000
Towers for 8 lights on land, including foundation.....	8,880
Concrete structures for 6 lights on marine sites.....	28,200
Structures for 9 lights on land.....	6,300
Illuminating apparatus for 23 lights.....	32,700
15 tall-type buoys and moorings.....	7,000
Total.....	95,000

No. 10. *Depot for eighth lighthouse district.*—Constructing and equipping a light-house depot for the eighth lighthouse district, at New Orleans, La., or vicinity, \$88,500.

NOTE.—The act of June 20, 1918 authorized this work, but no appropriation was made therefor. A lighthouse depot at New Orleans, La., is of great importance for the convenient and economical administration of the district. It should be at district headquarters, where supplies and materials are readily available and where shipments by rail and steamer could be received and accumulated for distribution by tender or other means at the proper time. The lamp shop should be located at this depot, as at present all intercourse with the mechanic in charge is by mail and telegraph, which is an inefficient method and the cause of numerous delays, and the present quarters are crowded, inadequate, and badly located. The stock and stores, excluding buoys and appendages, should be under the eye of the superintendent at all times. The present depot at Port Eads, La., at the South Pass of the Mississippi River, is nearly 100 miles from district headquarters. A desirable site has been secured for the proposed depot, through a permit from the Treasury Department to use a portion of the river frontage outside of the levee at the marine hospital, New Orleans, La. Detailed estimate:

Wharves on cressoted piling.....	\$60,000
Structural steel depot shed.....	18,000
Lamp shop, blacksmith shop, oil house, and interior finish of buildings.....	10,500
Total.....	88,500

No. 11. *Riprap protection, etc., for light stations, third lighthouse district.*—To provide riprap to reinforce foundations and protect them from damage by sea and ice and make more accessible boat landings at the following stations, \$284,000.

NOTE.—Practically all these stations are on submarine sites, and those not so located are subject to damage from the sea. During the past winter the foundations of many of these stations were considerably damaged and weakened by ice, and many of the smaller lights, such as post lights and dolphins were carried away, seriously interfering with navigation. These lights have been rebuilt, but they should be protected by riprap to prevent danger of their being carried away again in the future. At most of these stations proper provision has not been made for a safe landing for small boats, and landing in bad weather is both difficult and hazardous.

1. Cold Spring Harbor Light, N. Y.....	\$12,800
2. Plum Beach Light, R. I.....	7,950
3. Southwest Ledge, Conn.....	4,465
4. Little Gull Island, N. Y.....	10,500
5. Baybrook Breakwater, Conn.....	1,425
6. Stratford Shoal (Middle Ground), N. Y.....	13,500
7. Race Rock, N. Y.....	16,000
8. Esopus Meadows, N. Y.....	6,330
9. Orient Point, N. Y.....	11,350
10. Norwalk Harbor Post Lights (Round Beach, Fitchs Point and White Rock Reef), Conn.....	22,800
11. Stamford Harbor (Pine Island Front), Conn.....	3,500
12. Port Chester Channel, N. Y.....	5,250
13. Great Kills, N. J.....	8,000
14. Junction Light, N. J.....	3,000
15. Thames River, Conn. (Scotch Caps, Ice House, Long Beach, Lower Long Beach, Upper, Pride Pier, Burnt House Pier, and Sand Pier Lights).....	26,580
16. Old Orchard Shoal, N. Y.....	9,900
17. Penfield Reef, Conn.....	7,760
18. Latimer Reef, N. Y.....	3,255
19. Colchester Reef, Vt.....	10,980
20. Greens Ledge, Conn.....	9,900
21. Rockland Lake, N. Y.....	7,500
22. Stamford Harbor, Conn.....	6,275
23. Cedar Island, N. Y.....	5,700
24. Bristol Ferry, R. I.....	1,800
25. Borden Flats, R. I.....	3,950
26. Bullocks Point, R. I.....	3,600
27. Sabine Point, R. I.....	1,500
28. Hog Island, R. I.....	5,635
29. Execution Rocks, N. Y.....	4,380
30. Wickford Harbor, R. I.....	4,380

31. Great Beda, N. J.	\$12,125
32. Conimicut, R. I.	3,778
33. Pecks Ledge, Conn.	8,125
34. Coxsackie, N. Y.	2,000
35. Hudson City, N. Y.	2,000
36. Bridgeport Harbor, Conn.	5,925
37. Stepping Stones, N. Y.	3,150
38. Mussel Bed Shoals, R. I.	1,775
39. Tarrytown, N. Y.	1,925
Miscellaneous	225
Grand total	284,000

No. 12. *Charleston, S. C., Lighthouse Depot.*—For completing the lighthouse depot at Charleston, S. C., and constructing an administration building for the sixth lighthouse district, \$115,000.

NOTE.—The act of October 22, 1913 (38 Stat., 244), appropriated \$125,000 toward the purchase of a site and construction of a wharf and buildings and equipment, so far as funds might permit for a depot for the sixth district. This entire appropriation has been expended, but all the necessary facilities have not been provided. The site itself cost \$60,000 and the wharf \$46,418. Further requirements to complete the depot include dwellings for keeper and assistant keeper, who are required to live on the reservation, additional filling, water and sewer systems, walks, roads, oil house, blacksmith shop, additional equipment, etc. Without the completion of this project the district organization is inadequately equipped to efficiently perform its duties.

An office or administration building is needed at the site of the new depot, where necessary land is available. The sixth district office now occupies the "Old Exchange" building in Charleston, which, pursuant to act of Congress approved March 4, 1913 (37 Stat., 889), was on April 20, 1917, deeded by the Secretary of the Treasury to the Order of the Daughters of the American Revolution. The Government does not, therefore, own the building, but it is being occupied by the inspector's office under authority of the statute cited, providing for such occupancy until other suitable quarters are provided. More than half of the building has been vacated by the Lighthouse Service, and it is essential that other suitable quarters be provided for proper administration work of the district.

The logical location for such a building is at the depot site, which is the center of district activities. Detailed estimate:

Administration building	\$54,000
Two keepers' dwellings	12,000
Oil house	7,800
Blacksmith shop	2,700
Concrete buoy storage	5,000
Walks, roads, grading, water and sewer system, etc.	17,300
Equipment and fire protection	15,000
Total	115,000

No. 13. *Depot for seventh lighthouse district.*—Purchasing site for and constructing and equipping a lighthouse depot for the seventh lighthouse district, \$200,000.

NOTE.—The Lighthouse Service storehouse, wooden smithy, and wharf are on property belonging to the Treasury Department. The wooden storehouse and wharf, which are highly inflammable, are located between the Navy coal sheds and piers A and B, one of each on each side and are, therefore, in an unusually dirty location. The coal dust is practically always in motion, and when the coal conveyors are in operation it blows about in clouds. It finds its way into the depot keeper's quarters and into the storehouse, where thousands of dollars' worth of property is stored, which it is impossible to keep clean. These coal sheds have been erected since the storehouse was built. Furthermore, there are frequently several Navy torpedo-boat destroyers lying alongside at the Navy piers on each side of the depot wharf, which in addition to causing a great deal of dirt are a menace to the lighthouse tenders on account of collision. A new site and wharf are now urgently needed for the efficient and economical work of the district. Detailed estimate:

Purchase of water-front property	\$100,000
Construction of wharf, including track	24,000
Bulkheading	10,000
Water mains	350
Service building, keeper's dwelling, storehouse, oil house, machine shop, carpenter shop, and blacksmith shop	59,000
Boundary fence, buoy skids, and chain platform	3,104
Shop equipment	3,496
Total	200,000

No. 14. *Aids to navigation, Alaska.*—For establishing new aids to navigation and for improvements to existing aids, in Alaska, \$75,000.

NOTE.—The appropriation of \$60,000 made by the act of June 12, 1917, for this purpose has practically all been obligated, and it is expected that projects to which the funds are applicable will be completed by the end of the present calendar year. There is a demand from maritime interests for the further establishment of new aids to facilitate and safeguard water transportation in Alaska, where navigation is unusually difficult and hazardous, as shown by the frequency of marine disasters occurring in these waters. A number of unwatched lights on shore or reefs and on buoys are needed to mark the principal routes of navigation through inside passages. A few such lights are needed to mark headlands on the outside coast for the benefit of coasting traffic, and there are a number of requests for lights to mark the entrance to harbors where fish packing or other plants are located. The fishing industry in Alaska is now being greatly expanded, and many new plants are being constructed in localities not heretofore visited by large steamers. This fact has given rise to a greatly increased demand for new aids. Estimate of cost:

2 gas buoys, at \$7,000	\$14,000
2 gas buoys, at \$5,000	15,000
2 acetylene lights on steel towers, at \$3,800	7,200

3 acetylene lights on wooden houses, at \$3,000	\$9,000
4 acetylene lights on wooden houses, at \$2,100	8,400
8 acetylene lights on wooden houses, at \$1,200	9,600
6 acetylene lights on wooden houses, at \$800	4,800
Miscellaneous minor aids	7,000
Total	78,000

No. 15. *Ludington, Mich., aids to navigation.*—Improving aids to navigation and establishing new aids at Ludington, Mich., \$50,000.

NOTE.—The present location of the fog-signal station on the end of south pier subjects vessels to danger of striking the breakwater. The commerce of Ludington, which includes important car-ferry lines across Lake Michigan, is as important as any other port on the east shore of Lake Michigan, and as this port is most inadequately lighted now this improvement is considered well warranted. It is proposed to establish a main light on the outer end of the north breakwater, with fog-signal apparatus, consisting of electrically driven air compressor and compressed-air fog signal with oil engine reserve drive, and to discontinue the present steam fog signal in old wooden structure. Quarters for keepers should be erected adjacent to the light, as it is unsafe to cross the harbor during the winter when the ice is broken up by car ferries. Detailed estimate:

Foundation and tower	\$7,000
Fog-signal building	6,300
Illuminating apparatus	2,500
Fog-signal apparatus	7,000
Quarters for three keepers, including site	22,500
Minor lights on north and south pierheads	3,500
Total	50,000

No. 16. *Tampa Bay, Fla., aids to navigation.*—Establishing and improving aids to navigation in Tampa Bay, Fla., \$17,500.

NOTE.—Tampa is an important seaport with a large and growing commerce by sea. Owing to shallow water in Tampa Bay, deep-draft vessels can reach the city from the Gulf only by means of several comparatively narrow dredged cuts. Provision has already been made for lighting all of the important cuts excepting Cut D, for which lights should be provided as soon as practicable, as large vessels must pass through this cut in order to reach Port Tampa. Detailed estimate:

Concrete foundation	\$1,900
Metal-work towers	9,800
Illuminating apparatus	5,800
Total	17,500

No. 17. *Delaware Bay Entrance, aids to navigation.*—Improving the aids to navigation at the entrance to Delaware Bay, \$148,500.

NOTE.—In consequence of the continued erosion of the shore line in the vicinity of Cape Henlopen Light, Del., the early destruction of that light is anticipated, measures taken for the preservation of the shore line having proved unavailing. Every purpose now served by Cape Henlopen Light would be better served by the rebuilding of Harbor of Refuge Light to a height of about 140 feet. The establishment of large gas buoys is also required, one midway between, and in the line connecting Five Fathom Bank Light Vessel and Overfalls Light Vessel, one at the extreme lower and outer end of Hen and Chickens Shoal, and one in approximately the present position of Fifteen Foot Shoal Buoy. With the improvements recommended herein, including a red sector in the new Harbor of Refuge Light to cover Brown Shoal, the ultimate fate of Cape Henlopen Light will have no bearing on the practical needs of navigation in this vicinity. Detailed estimate:

Rebuilding Harbor of Refuge Light Station	\$127,800
3 gas and bell buoys on station	12,000
1 relief gas and bell buoy	4,000
2 extra gas tanks	1,200
2 extra buoy lanterns	2,000
Sinkers and moorings for buoys	1,500
Total	148,500

No. 18. *Goose Island Flats, N. J., Light Station.*—Establishing a light and fog signal at or near Goose Island Flats, N. J., \$140,000.

NOTE.—Vessels navigating the Delaware River are obliged to make a decided turn at this point. A temporary structure, protected by riprap, was carried away by the ice in January, 1910, although the riprap is partially in place and forms a menace to navigation unless properly marked. A buoy is now maintained at this location, but in winter it is impossible to keep it in position on account of the heavy ice. It is proposed to erect a light and fog signal, on a suitable heavy caisson foundation, close to the channel on the easterly side. Detailed estimate:

Foundation in place	\$65,000
Riprap protection for foundation	15,750
Erection of superstructure	48,750
Illuminating apparatus	3,800
Fog-signal apparatus	6,900
Total	140,000

No. 19. *California and Nevada aids to navigation.*—Establishing aids to navigation, California and Nevada, \$37,775.

NOTE.—Petitions have been received from numerous individuals, merchants, and owners and operators of barges and tugs for lighting the channel between Point San Mateo and the mouth of Alviso Slough. This waterway is the natural outlet for nearly all the produce of the extensive Santa Clara Valley, and the

annual traffic, which is now reported to be upward of 50,000 tons, will be greatly increased if the channel is properly marked. The deep channel is narrow and winding, and at present there are no aids to assist mariners in keeping off the shoals at night. Much of the traffic must be carried on at night to take advantage of the tides. A petition to the Secretary of Commerce, dated November 16, 1916, asks for various lighted aids in this locality, which are urgently needed and should be established at once. Gas buoys should also be provided at Fort Rose and Point Buchanan. The act of August 28, 1916 (39 Stat., 538), authorized aids to navigation on Lake Tahoe, Cal. and Nev., but no appropriation was made therefor, and funds have not been available from the general appropriations of the Lighthouse Service. Lake Tahoe has an area of approximately 200 square miles, is 21 miles long, has a mail route 70 miles long, and a great many passengers are carried on numerous steamers and launches there annually. Detailed estimate:

3 type "L" acetylene buoys, at \$3,000.....	\$9,000
2 type BW 600-11 acetylene buoys, at \$5,000.....	10,000
1 type "O" acetylene buoy.....	4,080
7 type "S" acetylene buoys, at \$1,200.....	8,400
Establishing 6 minor lights and 5 day marks.....	4,667
Illuminating apparatus.....	1,708
Total.....	37,775

No. 20. *Depot keepers' dwellings.*—For the construction of two dwellings at the Goat Island Lighthouse Depot, \$16,500.

The present quarters at the Goat Island Lighthouse Depot, consisting of two old frame dwellings located just above high water, are poorly arranged, insanitary on account of their locations, and wholly inadequate to accommodate the depot force. Two families at present occupy one cottage of seven rooms and three families occupy another cottage of eight rooms. There are no quarters available for the assistant depot keeper or the mechanic, both of whom are required to make long journeys to and from San Francisco each day. On account of the position of Goat Island in the middle of San Francisco Bay with no ferry service except the irregular one provided by the naval training station on the island, it is essential that the depot keepers and the mechanic, all of whom are in charge of important work at the depot, should be quartered there in order to properly carry on their work. Two dwellings are required to be built on the higher ground adjacent to the depot for the accommodation of the keeper and the mechanic in charge of the depot shops. Estimate of cost:

Two dwellings, hollow-tile construction.....	\$16,500
----------------------------------------------	----------

Total group No. 1, authorized by law, \$1,653,500; not yet authorized, \$1,084,275.
Total, \$2,737,775.

GROUP NO. 2.

Works considered essential for the needs of navigation and the equipment of the Lighthouse Service, and which it is recommended be undertaken as resources permit, are submitted with estimates of cost. (These items have been selected from a much larger number of recommendations submitted by the superintendent of the lighthouse districts and others.)

No. 21. *Point Pinos, Cal., Light Station.*—For improving Point Pinos Light Station, Cal., \$37,500.

NOTE.—Improvements to the combined tower and dwelling at this station are required to keep them in a serviceable condition. Fogs are of frequent occurrence at this point, and a first-class compressed-air signal, together with quarters for two additional keepers, are urgently required. Traffic into Monterey Harbor is steadily increasing and a number of large oil-carrying steamers now run regularly to this port where oil is piped from the oil fields in the interior of the State. Numerous requests have been received from shipping interests to establish a first-class fog signal at this point. The Union Oil Co. has lost one steamer at the entrance to this harbor. There is an average of 800 hours of fog per annum at this station. Detailed estimate:

Fog-signal building.....	\$4,500
Fog-signal apparatus.....	11,500
Dwelling for two keepers.....	16,000
Improvements to present station.....	5,500
Total.....	37,500

No. 22. *Michigan Island, Wis., Light Station.*—For establishing and improving aids to navigation at or near Michigan Island, Lake Superior, Wis., \$85,000.

NOTE.—The act approved May 27, 1908 (35 Stat., 332), appropriated \$2,000 to make a survey and estimate of cost and report upon the feasibility and need of establishing a light and fog signal upon Gull Island or the easterly end of Michigan Island, Apostle Group. As a result of this survey, the conclusion has been reached that the eastern end of Michigan Island is the better site. The act of June 7, 1910 (36 Stat., 536), authorized the construction of a light and fog-signal station at Michigan and Gull Islands at a cost not to exceed \$140,000, but no appropriation has been made therefor. A further study indicates that the best plan is to elevate the present light near the westerly end of Michigan Island, add a fog signal, and establish a nonattended acetylene light on Gull Island. This arrangement would serve as a better guide to vessels passing in either direction. The project now contemplated will not cost as much as the amount authorized. Detailed estimate:

Foundation, main light.....	\$3,000
Dwellings for three keepers.....	20,000
Tower complete (erection only).....	6,000
Minor light.....	9,496
Illuminating apparatus.....	10,000
Fog signal and hoisting apparatus.....	13,550
Fog-signal building, boathouse, and other buildings.....	13,455
Boats, tramway, walks, etc.....	9,500
Total.....	85,000

No. 23. *Kauhola Point, Hawaii, Light Station*.—For improving the light station at Kauhola Point, Hawaii, \$20,000.

NOTE.—Owing to the importance of this station, located near the northern point of the Island of Hawaii, steps have been taken to change the present lens-lantern light to a converted flashing fourth-order lens. To support this lantern and lens and to complete the improvement of this station, a new tower is necessary. A dwelling for the assistant keeper should also be provided. Detailed estimate:

75-foot cast-iron tower in place.....	\$14,750
Foundation for piers for tower.....	1,000
Dwelling.....	4,000
Improvement to grounds.....	250
Total.....	20,000

No. 24. *Anacapa Island, Cal., Light Station*.—For establishing a light and fog signal at or near Anacapa Island, Cal., \$115,000.

NOTE.—Practically all coastwise vessels and a large number of those bound for Panama use the Santa Barbara Channel. The desirable course leads close to the eastern end of Anacapa Island, which is now marked by a small beacon light, not sufficiently powerful to be of service in hazy weather. The American Shipmaster's Association has presented a petition for a light and fog signal, indorsed by the San Francisco and Los Angeles chambers of commerce and important shipping interests on the Pacific coast. It is therefore recommended that a light of high candlepower and a first-class fog signal be established at this point as soon as practicable. Detailed estimate:

Light tower.....	\$16,800
Illuminating apparatus.....	6,800
Fog-signal building and apparatus.....	18,100
Two sets double quarters for four keepers.....	33,000
Oil house, outbuildings, etc.....	7,700
Wharf, launch landing, and derrick.....	8,500
Roads, grading, and fencing.....	5,000
Water supply and sewerage system.....	13,000
Launch and station boats.....	4,000
Total.....	115,000

No. 25. *Santa Barbara, Cal., Light Station*.—For improving Santa Barbara Light Station, Cal., \$33,000.

NOTE.—The station is old and the tower is too small to accommodate the revolving lens now installed in it. The tower stands one-eighth of a mile back from the point of the shore line and the light is partly obscured by trees on other properties. A new tower is required to be built farther out on the point. Coastwise vessels bound north keep close inshore to avoid the prevailing northwesterly winds and sea, and a fog signal should be established here with quarters for two additional keepers. An improvement has been made in changing the light from fixed to flashing and an increase of intensity. The fog signal as well as other improvements, and a new light tower, are necessary to render the aids efficient. Detailed estimate:

Tower, lantern, and fog-signal building.....	\$10,000
Fog-signal apparatus.....	11,500
Additional quarters.....	8,400
Improvements to present station.....	3,100
Total.....	33,000

No. 26. *Cape Spencer, Alaska, Light Station*.—For establishing a light and fog-signal station at or near Cape Spencer, Alaska, \$145,000.

NOTE.—Cape Spencer is at the entrance to Cross Sound and Icy Strait, through which pass all vessels running from Puget Sound ports to Prince William Sound, Seward, Cook Inlet, and Kodiak, excepting only occasional freighters proceeding by the outside route. With the construction of the proposed Alaskan railroad the traffic by way of Cape Spencer will be materially increased. A small unwatched light is now maintained on the cape, but it is believed that a large watched light and fog signal should be provided, especially for vessels returning from the westward, to be used as a landfall, as it is important that they be given all possible assistance, especially in thick weather. Maritime interests have urged the establishment of this aid. Detailed estimate:

Transportation and housing of materials and men.....	\$26,000
Main station structure.....	71,500
Tower superstructure and metal work.....	17,500
Minor structures.....	10,400
Illuminating apparatus.....	10,600
Fog-signal apparatus.....	9,000
Total.....	145,000

No. 27. *Staten Island, N. Y., Lighthouse Depot*.—For construction and equipping a floating dry dock at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., \$200,000.

NOTE.—Owing to the great number of vessels in the third lighthouse district (7 tenders and 14 light vessels) and vessels from other districts that come to the general depot for repairs, a dock of this kind is urgently needed and will result in a great saving to the Government. In the present conditions of shipbuilding and repair work it is very difficult to have repairs to lighthouse vessels done at all. Detailed estimate:

2,000 tons capacity dry dock.....	\$200,000
-----------------------------------	-----------

No. 28. *Portage Lake, Mich., aids to navigation.*—For establishing a light and fog-signal station upon a new site and improving aids to navigation at Portage Lake Ship Canals, Mich., \$100,000.

NOTE.—The War Department intends to remove the breakwater, and it is therefore necessary to rebuild the light and fog signal on a new site. The new light and fog signal should be established on a pier at the outer entrance, where it would be of the best service to vessels making the harbor. The construction of the station proposed will require considerable time to complete, and this project should have consideration for that reason. The harbor pier on which the present pierhead light station and fog-signal house stand, as well as the timber superstructure under the fog-signal house, are rapidly deteriorating, and it is doubtful if these structures can be maintained much longer in a safe condition unless extensive repairs are made to their foundations, which would be unnecessary in the event of the establishment of the proposed new station. Detailed estimate:

Foundation and concrete base of tower.....	\$64,000
Superstructure.....	22,500
Fog signal and lighting equipment.....	13,500

Total..... 100,000

No. 29. *Ram Island, Me., Light.*—For establishing a light on Ram Island, lower Kennebec River, Me., \$5,400.

NOTE.—The need of this light has several times been expressed by petition. Ram Island is about 54 miles below Bath, Me.; it is a low island in the middle of the river, with a string of half-tide ledges making off on the easterly side. There is a passage on either side, and at some stages of the tide a 5-knot current exists, from which several accidents have occurred. About 420,000 tons of freight and 175,000 passengers are transported past this island annually, not including the many pleasure craft and small boats which frequent the river. It is proposed to establish an acetylene light on or near the easterly side of Ram Island. Detailed estimate:

Light structure, including site.....	\$3,050
Illuminating apparatus and installation.....	1,950
Contingencies.....	400

Total..... 5,400

No. 30. *Cape Kumukahi, Hawaii, Light.*—For establishing a light at or near Cape Kumukahi, Hawaii, \$22,000.

NOTE.—Cape Kumukahi is the easternmost cape of Hawaii. There is at present no landfall light for vessels bound to Hilo from the Panama Canal or from the southeast. It is a difficult point to round when sailing from Hilo to the south point or vice versa. A light on this point would be a great improvement to the lighting of the islands. The country in this vicinity is barren, undulating lava rock. An acetylene light is recommended, with a focal-plane height of about 150 feet, which would be visible about 20 miles. Landing from seaward at the cape is impossible at most times, and the only practical method of supplying this station would be by railroad from Hilo to Kapoho and then by wagon road 3 miles to the cape, 14 miles of which would have to be constructed over the rock. Detailed estimate:

Station site and right of way for road.....	\$500
Concrete foundation for tower.....	740
Superstructure, tower.....	9,000
Illuminating apparatus.....	4,640
Roadway, construction of.....	7,120

Total..... 22,000

No. 31. *Henderson Point, Me., Light Station.*—For establishing a light and fog signal at or near Henderson Point, Piscataqua River, Portsmouth Harbor, Me., \$7,500.

NOTE.—The need of this aid has several times been expressed by petition. It is often very difficult to locate Henderson Point at night and in thick weather; the channel is narrow and there is a strong tide at this point, where the course changes. The commercial statistics for Portsmouth Harbor indicate about 5,600 vessels arriving and departing annually, transporting about 610,000 tons of freight. It is proposed to establish an acetylene light with fog bell. Detailed estimate:

Structure, including site.....	\$3,350
Illuminating and fog-signal apparatus.....	3,750
Contingencies.....	400

Total..... 7,500

No. 32. *Port Real, P. R., or East Point Vieques Island, Light Station.*—For establishing a light station at or near Port Real, P. R., or East Point Vieques Island, \$40,000.

NOTE.—The lighthouse at Port Ferro, on the south coast of Vieques, or Crab Island, is one of the primary seacoast lights of the Porto Rican system. The light tower and the keepers' dwelling attached to it are built on top of a rocky promontory undermined for some time by the sea, and the whole structure, already dangerously cracked, is in danger of collapsing. It is urgent to rebuild a lighthouse at or near this point, as this is an important aid to the navigation from St. Thomas to Cuba and other West Indian Islands and the Caribbean Sea. A light in this vicinity is necessary for navigation, and it is proposed to dismantle the present Port Ferro Light Station and to erect a new light station at Port Real, about 3 miles westward, where the aid will be more useful and on better ground than on its present location at Port Ferro, as Port Real is the most important and the best anchorage around Vieques Island. The present apparatus at Port Ferro is to be used for this new station. Detailed estimate:

Tower and dwellings for two keepers.....	\$25,000
Outbuildings and fence.....	1,000
Purchase of site.....	2,000
Grading and walks.....	1,000
Installation of illuminating apparatus.....	1,000

Metal work.....	\$3,000
Woodwork.....	2,000
Total.....	40,000

No. 33. *Nine Mile Point, Mich., Light Station.*—For establishing a light and fog-signal station at or near Nine Mile Point, Mich., \$50,000.

NOTE.—When Forty Mile Point Light Station was established it was placed on the site designated Forty Mile Point on the county-survey charts. Sailing masters expected the station to be placed at Nine Mile Point, near the entrance to the Straits of Mackinac, but which was not so called officially then. While Nine Mile Point is within the visibility of Spectacle Reef and Poe Reef Light Vessel lights, a fog signal would be of especially great service in thick and foggy weather and during seasons when forest fires prevail. Not less than nine strandings occurred here between 1903 and 1909. In the event of establishing this station, Forty Mile Point could be made a minor light. Detailed estimate:

Tower and fog-signal building, including site.....	\$26,100
Illuminating apparatus.....	5,500
Fog-signal apparatus.....	2,000
Dwellings for three keepers.....	12,000
Outbuildings, boathouse, fences, etc.....	2,600
Boats and equipment.....	1,800
Total.....	50,000

No. 34. *Caribbean Sea, aids to navigation.*—For establishing aids to navigation in the Caribbean Sea along routes leading to the Panama Canal, \$75,000.*

NOTE.—The need for aids to navigation in the Caribbean Sea has become more urgent with the increase of traffic due to the Panama Canal, and such aids have been requested by the steamship companies using these routes. It is proposed to establish gas and whistling buoys at Farrall Rock (Gorda Bank), Southwest Cay (Serrana Bank), Formigas Bank, and Blower Rock (Pedro Bank), and unwatched acetylene light on the south end of Old Providence Island, another unwatched light at Courtown Cays and a first-class can buoy to mark the north and shoal of Old Providence Island. Detailed estimate:

4 gas and whistling buoys with moorings, etc., on station.....	\$26,000
2 gas and whistling buoys with moorings, etc., relief.....	13,000
1 first-class can tail-type buoy.....	1,000
2 towers in place.....	30,000
Illuminating apparatus.....	5,000
Total.....	75,000

No. 35. *Galveston Jetty Light Station, Tex.*—For improving Galveston Jetty Light Station, Tex., \$8,500.

NOTE.—The appropriation for this station is insufficient for the purchase and installation of a sufficiently powerful fog signal. It is recommended that a compressed-air fog signal be installed as soon as funds permit. Detailed estimate:

Compressors.....	\$5,000
Fog-signal apparatus.....	2,000
Piping and installation.....	1,500
Total.....	8,500

No. 36. *Grays Harbor Light Station, Wash.*—For improving Grays Harbor Light Station, Wash., \$15,000.

NOTE.—The present steam fog-signal plant at this station is located in a frame building. Both the machinery and building are quite old and in poor condition. It is proposed to construct a new fireproof building and install an electrically operated siren as soon as funds permit. Detailed estimate:

Fog-signal building.....	\$6,500
Purchase and installation of apparatus.....	8,500
Total.....	15,000

No. 37. *Lighthouse depot in vicinity of Newport, R. I.*—For purchasing site and building wharf and storehouse for new lighthouse depot in Narragansett Bay, same to be located at Newport, R. I., or vicinity, \$82,300.

NOTE.—The present depot is located on the breakwater at Newport Harbor, this location being very unsatisfactory and inconvenient, as the water at the dock is too shoal for the larger tenders, and there are no facilities for tenders getting water, or having provisions, etc., delivered, which necessitates the tenders going to Newport for provisions, etc., causing much waste time during working hours. The Navy Department is building along the breakwater continuously and the present plans of the Navy bring them down to the lighthouse depot. The present dock is in very bad condition, due to age, decay, and worming of piles, and at present is unsafe for further use. Improvement of the depot on the existing site is not considered economical, owing to lack of space and other conditions. Detailed estimate:

Purchase property for new depot.....	\$40,000
Building new wharf.....	37,800
Building new storehouse.....	4,500
Total.....	82,300

* Upon the recommendation of the Secretary of Commerce an allotment of \$100,000 has been made by the President from the appropriation for national security and defense for the project covered by Item No. 34.

No. 38. *Lake Champlain, N. Y.*—To establish acetylene lights, build and equip a gasoline tender, and rebuild Juniper Island Light Station wharf to accommodate the tender on Lake Champlain, \$150,000.

NOTE.—In the interest of efficiency and economy it is proposed to discontinue all oil lights on Lake Champlain except at stations where there is a fog bell, and establish acetylene lights in their places. The motor-driven tender will remain constantly on the lake to care for the operation and repair of the light stations. This change from oil to acetylene will result in considerable saving. It will permit better care and maintenance of the aids to navigation on Lake Champlain and relieve the tender *Daisy* from this work, thus enabling her to do more work in the vicinity of New York Bay, where her services are much needed. Detailed estimate:

8 large lights	\$25,000
21 small lights	55,000
Gasoline tender	25,000
Rebuilding wharf at Juniper Island Light Station, with storeroom, gas-tank house, and ways for taking tender out of water in winter	45,000
Total	150,000

No. 39. *Sag Harbor, N. Y.*—For establishing five acetylene lights in the channel leading into and in the vicinity of Sag Harbor, N. Y., and improving illuminating apparatus at Sag Harbor Breakwater and Cedar Island Light Stations, \$45,700.

NOTE.—This channel is crooked, narrow, and rocky, and a system of acetylene flashing lights is much needed. It is proposed to place the lights on steel towers having concrete and riprap foundations. Detailed estimate:

5 acetylene lights complete	\$30,600
Improving illuminating apparatus, Sag Harbor Breakwater Light	6,100
Improving illuminating apparatus, Cedar Island Light	9,000
Total	45,700

No. 40. *Manitowoc, Wis.*—For improving aids to navigation and building keepers' dwellings, \$16,000.

NOTE.—The aids to navigation at this station are now being improved by the construction of a steel fog-signal house and light structure and the installation of an improved light and fog signal, under an appropriation of \$21,000, made by act of June 12, 1917.

The keeper's present dwelling is an old house and will constantly necessitate the expenditure of considerable amounts for repairs and upkeep. It is badly located with reference to the lights in charge of the keepers. The dwelling should be located near the inner end of the breakwater, overlooking the harbor. Detailed estimate:

Dwelling:	
Site	\$500
Brick or tile dwelling	13,500
Necessary outbuildings, fences, walks, grading	2,000
Total	16,000

No. 41. *Repairs and improvements, light stations, Alaska.*—For repairs and improvements to existing aids to Alaska, \$70,000.

NOTE.—Owing to the increasing volume and importance of the commerce of Alaska, it is very desirable that important improvements be made in certain lights and fog signals, as urged by mariners. Also, it is necessary to replace some worn-out station equipment, and at some stations improvements are needed for the betterment of protection of the station. At Guard Island, an important station at the westerly end of Tongass Narrows, it is desired to replace the present unsatisfactory fog bell with an air diaphone and to construct a suitable permanent light and fog-signal building to replace present temporary wooden tower; also to erect another dwelling in order that two keepers may be assigned instead of one as at present, and thus provide for continuous night and day watches. At Point Retreat, an important station, there is now only an unwatched acetylene light and no fog signal. All regular vessels plying between southeastern and southwestern Alaska pass this point, either by way of Favorite Channel or by way of Lynn Canal and Skagway. It is proposed to establish an air diaphone fog signal and assign keepers, a suitable permanent structure to be erected for the light and fog signal, and unused dwelling now at the station to be repaired and refurnished for the use of the keepers. At Scotch Cap it is proposed to install a flashing lens in place of present fixed lens, which will increase the power of the light and render it distinctive from other fixed lights. This is an important coast station located on Unimak Pass and is made by all vessels passing from the Pacific Ocean to Bering Sea. Shore protection is also needed at this station, as the dwellings are threatened by encroachment of the sea, and new machinery is needed to replace that worn out in service. At Tree Point Light Station present water supply is subject to interruption through freezing and is not considered healthful. It is proposed to lay a pipe line to a lake about 1 mile distant. Mariners have complained that the air siren fog signal at Cape Hinchinbrook Light Station is not effective, and it is desired to replace same with an air diaphone. This is a very important station situated at the entrance to Prince William Sound. Detailed estimate:

Guard Island Light Station.—Install diaphone, construct light and fog-signal building, erect dwelling, etc.	\$28,000
Point Retreat Light.—Install diaphone, construct light and fog-signal building, repair dwelling, etc.	27,000
Scotch Cap Light Station.—Purchase new compressors and engines, install flashing lens in place of fixed lens, construct shore protection	9,500
Tree Point Light Station.—Construct pipe line from lake to station	1,530
Cape Hinchinbrook Light Station.—Install diaphone in place of present siren	1,400
Contingencies, repairs, and improvements	2,570
Total	70,000

Total, group No. 2, \$1,322,900 (not included in total of estimates).

DESCRIPTIONS OF NEW WORKS COMPLETED.

The following are brief technical descriptions of important lighthouse works completed since the end of the fiscal year 1917:

AIDS TO NAVIGATION, CAPE COD CANAL, MASS.

Purpose.—On completion of the Cape Cod Canal, the dredged channel in Buzzards Bay leading to same, and the breakwater at the eastern Sandwich entrance, it became necessary to light these two entrances and also increase the intensity of the light and power of the fog signal at the Wings Neck Light Station.

Sites.—Canal Breakwater Light is located near the outer end of Cape Cod Canal Breakwater, Sandwich, Mass., about 2,000 feet from shore, and is supplied with electric current for operating the light through an armored lead-sheath submarine cable leading to shore.

Lighted beacons Nos. 5, 5A, 6, 6A, 7, 8, 9, 10, 11, 12, 13, 14, 15, and 17 were located along the dredged channel in Buzzards Bay leading to the westerly entrance to Cape Cod Canal, to mark its boundaries.

Wings Neck Light Station is located in Buzzards Bay, on the north side of entrance to dredged channel leading to Cape Cod Canal.

Structures.—Canal Breakwater: The foundation is a reinforced concrete slab 10 feet by 10 feet by 2 feet, located on top of breakwater. The slab supports a 30-foot steel skeleton tower and a meter house built on top of same.

Canal dolphin lights Nos. 5, 5A, 6, 6A, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 each consists of five creosoted white oak piles driven about 20 feet into the bottom, four of them in the form of a square 15 feet on a side, with the fifth pile in the center. The tops of the four outside piles were drawn into and bolted to the center pile, the whole then being bound together by three turns of one-half inch galvanized chain, securely spiked in place. The tops of the dolphins are surmounted each by a 7-foot by 7-foot wooden platform with railing and ladder and a wooden tank house 4 feet 6 inches by 4 feet 6 inches in place.

The acetylene lanterns surmount the tank houses.

Wings Neck fog-signal house is of brick, laid in cement mortar, concrete foundation and floors, and slate roof. Two cooling water cisterns are located beneath the floor at each end of the building.

Illuminating apparatus.—Canal Breakwater: The illuminating apparatus consists of a 300-millimeter lens lantern showing a fixed white light of 2,500 candlepower. The focal plane is about 40 feet above high water, and the light is visible 12 miles in clear weather. The light is furnished by a 250-watt concentrated filament mazda electric lamp, controlled from a transformer house at the shore end of the cable. The current is supplied by local electric light company from their 2,300-volt line, and is stepped down to 110 volts by a transformer.

Canal dolphin lights: The illuminating apparatus of the 14 lights consists each of a 200-millimeter acetylene lantern, showing flashing lights of the proper color to mark their respective sides of the channel, the red lights being 20 candlepower and the white lights 70. Their focal planes are each about 22 feet above high water. The light to each of these lanterns is furnished by a one-half foot burner using compressed acetylene gas, controlled by flashing mechanism.

Wings Neck: The illuminating apparatus consists of a fourth-order fixed lens showing a fixed white light of 2,900 candlepower. The light is furnished by a 35-millimeter type B vapor oil lamp.

Fog signal.—Wings Neck: The fog signal consists of a first-class reed horn operated by air compressed to 6½ pounds. The characteristic is a blast of 2 seconds duration followed by a silent interval of 18 seconds. The valve to horn is operated by automatic clocks in duplicate. The copper horn projects through the side gable of signal house and is about 25 feet above high water. The two steel air tanks are located at one side of the first floor with pipes leading to valve and reed box on second floor; the compressing plant consists of 9-horsepower single-cylinder vertical Mietz & Weiss oil engines, with 7 by 8 inch vertical compressor on same shaft, running at about 300 revolutions per minute; compressing outfits are in duplicate. The cooling water to oil engines and compressors is supplied by a 2 by 1½ by 2½ inch Blake duplex pump operated from the high-pressure air tank at 25 pounds pressure. The water is pumped from one end of each cistern and returned to opposite end of same cistern.

Cost.—An act of August 1, 1914, appropriated \$50,000 for Cape Cod Canal Lights, Mass. The 16 above-mentioned lights (omitting the signal house at Wings Neck, which was built from general expenses, Lighthouse Service, 1917), together with 1 acetylene high-power gas and bell buoy, 1 Pintsch gas and bell buoy, and 1 spar buoy at the western entrance, and 3 acetylene gas and bell buoys and 3 acetylene gas buoys at the Buzzards Bay entrance to dredged channel, were established at a cost of \$49,905 99.

The steel tower, steel tanks, piping, duplex pump, and air compressing outfits were purchased in the open market by informal contract; the horn, reed box, valve, and automatic clocks were obtained from the general depot at Tompkinsville, N. Y., and the field work was carried out by hired labor.

The work was started November, 1914, and completed October 1, 1917.

NAVASSA ISLAND LIGHT STATION, WEST INDIES.

Purpose.—The increase of traffic through the Windward Passage brought about by the opening of the Panama Canal made it necessary to build a light on Navassa Island, as vessels plying between Atlantic ports of the United States and the Canal Zone pass close by the island. The light went into commission October 21, 1917.

Site.—The island is located 30 miles west of Haiti, 90 miles south of Guantanamo Bay, Cuba, and is 2 miles long and 1 mile wide, of limestone rock formation, the sides rising perpendicularly from the sea to the lower level about 30 to 60 feet above the sea. From the inner edge of the lower level there is a steep slope to the upper level. The upper level is nearly flat and approximately 240 feet above the sea. The station is located on one of the highest spots in the southern part of the island, 245 feet above the water.

Structure.—The tower is built of reinforced concrete. The foundation block is 40 feet square, 6 feet deep, resting on solid rock. The shaft of the tower is cylindrical, 15 feet in diameter, with an overhanging gallery at the watch-room-floor level. Above the concrete walls of the watch room the tower is surmounted by a second order cast-iron helical bar lantern the focal plane of which is 150 feet above the grade line and 395 feet above mean high water. The third, sixth, service, and watch-room floors are of reinforced concrete. The intermediate floors consist of sectional cast-iron plates bolted to the walls of the tower. The stairs between landing are of cast iron. The cast-iron center column supporting the landings extends from the first floor to the watch room and is used as a well for the weights driving the illuminating apparatus.

Illuminating apparatus.—The illuminating apparatus consists of two fourth-order lenses, each with two 90° lens panels, mounted side by side on a revolving plate supported on ball bearings. Each lens is fitted with a 35-millimeter, type "A," incandescent oil lamp, and both lamps burn simultaneously. Two 90° spherical mirrors are placed behind each light. The lenses are mounted so that the beams from each lens coalesce at a short distance from the lantern and form a single flash. The characteristic is a double white flash every 30 seconds, each with an intensity of 47,000 candles, and is visible 27 nautical miles in clear weather. The kerosene for the lamps is stored in tanks at the foot of the tower and pumped to the service room by a self-measuring oil pump.

Quarters.—The quarters consist of a reinforced-concrete building 58 feet square, with a patio in the center. The building is a single-story structure with the roof sloping from the parapet of the outside walls toward the center, the roof being used as a collecting surface for rain water, which is caught and stored in the concrete cistern under the patio, whose storage capacity is 22,000 gallons. There are five rooms for the keeper and a storeroom on one side of the house and four rooms for each assistant on the other side. One living room in each apartment has a tile floor. The rest are concrete. The kitchens are fitted with Spanish stoves, porcelain-enamel sinks, and pitcher pumps. Each keeper has a pantry in the storeroom.

The landing is on the south side of the island at Lulu Bay. The landing is made from small boats by a hanging ladder on a ledge about 10 feet above sea level; thence by inclined concrete ramps to the lower level. A 2-ton crane of 15 feet swinging radius is installed at Lulu Bay for the purpose of taking up supplies and small boats. There is a railroad track from the landing to the light station, running first along the lower level for a distance of about 1,100 feet, then up a steep incline to the upper level, and finally along the upper level to the station a distance of about 1,200 feet. A gasoline hoisting engine is installed at the top of the steep incline for hauling supply cars from the lower level to the upper level, and a hand winch is provided near the station for hauling the cars out of the cut to the site itself.

Cost.—The station was established under the act of October 22, 1913, appropriating \$125,000 for the erection of a light station on Navassa. The amount expended to June 30, 1918, was \$116,159.40. The metal work and construction work was done by

contract. The work was commenced in January, 1916, and completed in November, 1917.

AIDS TO NAVIGATION, ASHTABULA HARBOR, OHIO.

Purpose.—For rearranging, rebuilding, and improving aids to navigation at entrance to harbor, necessitated by breakwater extensions enlarging the harbor. The principal light went into commission September 21, 1916, and its fog signal March 26, 1917. The minor light went into commission July 17, 1914.

Site.—The principal light and fog signal is located on the outer end of the west breakwater, with a minor light on the west end of breakwater opposite to it, both at the entrance to the harbor.

Structures.—The west pierhead is 40 by 60 feet in plan. The foundation timber crib filled with reinforced concrete and stone was built by the United States Engineer Department. The base of reinforced concrete was built up by the Lighthouse Service from a point 4 feet above mean lake level to an elevation of 16 feet.

The steel lighthouse structure was moved from its old location on the breakwater, a distance of about 1,800 feet, to the new pierhead, and an addition of similar construction, 20 by 24 feet in plan, one story high, built on to provide additional floor space required for the fog-signal plant. The interior of the building was reconstructed, using brick lining and plaster for the walls. The power-room floor is tile and the floors of the quarters are hardwood. A pipe railing is provided around the edge of the pier for protection. The building supports a fourth-order helical bar lantern whose focal plane is 35 feet 5 inches above the top of the pier.

The structure on the east breakwater pierhead is a standard 25-foot skeleton steel tower, resting on concrete foundation piers.

Illuminating apparatus.—The illuminating apparatus at the principal light consists of a fourth-order, 6-panel, revolving lens, mounted on a mercury float pedestal and using a type "A" 35-millimeter incandescent oil-vapor outfit. The light characteristic is a white flash every 5 seconds, with an intensity of 14,000 candles. The focal plane is 51 feet 5 inches above mean lake level and the light is visible 15 miles.

East breakwater. A 300-millimeter lens lantern is used in connection with an automatic acetylene-gas installation, the characteristic being a red flash every 3 seconds with an intensity of 80 candles. The focal plane is 37 feet above mean-lake level and the light is visible 9 miles.

Fog signal.—A type "F" diaphone, using compressed air. The power plant consists of a 25-horsepower direct-connected tandem engine and compressor unit, in duplicate, operating on kerosene or power distillate. The characteristic is one blast of 2 seconds every 20 seconds.

Quarters.—There are three keepers who have quarters in the new main building while on duty with a keepers' dwelling with quarters for two families ashore. The basement of the new building contains a cellar, cistern, coal bin, storeroom, and oil and paint room. The first floor contains the engine room, a bedroom, and bathroom. The second floor a living room, pantry, a bedroom, tank room, and hallway leading to watch room above.

Cost.—The aids were established under the act of October 22, 1913, appropriating \$45,000. Total cost to June 30, 1918, \$4,429.72. The work was done by hired labor and purchase of materials.

CLEVELAND HARBOR FOG SIGNAL, OHIO.

Purpose.—On the completion of the rubble-mound breakwater arms, and the establishment of the main light on the west arm, it became necessary to remove the fog signal to the same location in order to obtain the highest efficiency and concentrate the duties of the keepers. It went into commission August 18, 1916.

Site.—The fog signal is located on the outer pierhead on the arm extending from the west breakwater, main entrance to Cleveland Harbor, Ohio.

Structure.—A rectangular steel building 29 by 31 feet in plan and 24 feet high, connected with the tower by a passageway, was built. The roof is covered with asbestos shingles and a monitor for housing the fog signal was built on the ridge near the gable.

Fog signal.—The apparatus consists of a type "F" diaphone, using compressed air. The power plant consists of a 25-horsepower direct-connected tandem engine and compressor unit, in duplicate, operating on kerosene or power distillate. The characteristic consists of 2 blasts every 30 seconds.

Cost.—The fog signal was removed, reconstructed, and improved under the act of October 22, 1913, appropriating \$17,600 for the work. Amount expended to June 30, 1918, \$17,312.82. The metal work for the building was made under formal contract. Construction was made by hired labor and purchase of materials.

AIDS TO NAVIGATION, TOLEDO HARBOR, OHIO.

Purpose.—To increase the efficiency of Manhattan Range Lights marking the straight channel in Maumee Bay, which were too low and frequently obscured by smoke and vessels mooring in the lagoon. They were raised and lights reestablished May 24 and 25, 1918.

Sites.—The ranges are located on the north side of the entrance into the Maumee River from the bay, Toledo, Ohio. The front light is on an artificial island. The rear light is about two-thirds of a mile southwest from the front light on the bank of the river.

Structures.—The new structure replacing the old frame ones is a steel skeleton tower, square, pyramidal in shape. The focal plane of the front light is 33 feet 9 inches and of the rear 76 feet above the top of the foundation.

Illuminating apparatus.—The range lenses formerly in use were installed in the new towers. The illuminant is electricity, 75-watt concentrated filament lamps being used. The lights are operated on 32-volt current, and the installation is so arranged that in the event of any interruption in the city current the light will operate from a set of storage batteries. The batteries have sufficient capacity to run the lights for two or three nights without recharging. The city current is taken through tungsten rectifiers, reducing the voltage from 112 volts alternating current to 32 volts direct current and connected with the lights and batteries in such a way that under normal conditions the batteries are automatically kept fully charged.

The characteristic of the lights is fixed red with a rated candlepower of 36,000 and 56,000 for the front and rear, respectively. The focal planes are 40 and 83 feet, respectively, above mean lake level, and they are visible 13 and 17 miles.

Quarters.—There is one keeper at this station with quarters in the frame dwelling constructed when the station was established in 1895.

Fog signal.—There is no fog signal.

Cost.—The work was carried out under the appropriation of \$15,000 made by the act of July 1, 1916. The amount expended to June 30, 1918, \$13,231.81. Work was done by hired labor and purchase of materials.

AIDS TO NAVIGATION, ALASKA.

Purpose.—To meet the demands of the increasing commerce and to continue the work of establishing efficient aids to navigation, 6 acetylene lights, 1 gas buoy, and 1 oil post lantern were established at various points in Alaskan waters during the fiscal year ending June 30, 1918. Data relative to these aids are shown in the table following.

Quarters.—No quarters were provided. All acetylene lights are of unwatched type, using compressed acetylene in acetone, supplied from batteries of steel cylinders which contain a sufficient supply of gas to operate the light continuously between visits of the lighthouse tenders.

The oil post lantern is cared for by a keeper who receives \$10 per month for his services.

Cost.—The balance from the appropriations of August 1, 1914, and \$49,469.07 from the appropriation of June 12, 1917, was expended during fiscal year 1918.

Name of light.	Locality.	Structure.	Top of lantern above ground, in feet.	Illuminating apparatus.	Characteristic.	Intensity of light, in candles.	Focal plane above mean high water, in feet.	Miles seen.	Appropriation cost.	Date of establishment.
Black Rock.....	Revillagigedo Channel.	Gray cylindrical house on pyramidal skeleton structure.	29	Acetylenic lantern.	Flashing white (flash 0.3, eclipse 2.7 sec.).	130	42	9	\$2,926	Mar. 15, 1918
Helm Rock Gas and Bell Buoy. ^a	Summer Strait.....	Type L gas buoy.....	.....	.....do.....	Flashing white (flash 0.2 sec., eclipse 1.8 sec.).	130	12	8	1,777	Jan. 16, 1918
Kaigin Island.....	Cook Inlet.....	White wooden house..	10	.....do.....	Flashing white (flash 0.3 sec., eclipse 2.7 sec.).	130	30	9	2,755	Aug. 22, 1917
Klawak Island.....	San Alberto Bay.....	Red pyramidal wooden tower, upper part slatted.	28	Post lantern, oil.....	Fixed red.....	20	14	4	122	Apr. 1, 1918
Klawak Reef.....	.....do.....	White wooden house on square skeleton structure on concrete pier.	36	Acetylenic lantern.	Flashing white (flash 0.3 sec., eclipse 2.7 sec.).	130	40	9	2,341	Mar. 29, 1918
Middle Ground.....	Wrangell Strait.....	Black wooden house on white pile dolphin.	.....	.....do.....	Flashing white (flash 0.3 sec., eclipse 1.8 sec.).	10	23	4	600	Jan. 31, 1918
Point Crowley.....	Chatham Strait.....	White house on concrete base.	10	.....do.....	Flashing white (flash 0.3 sec., eclipse 2.7 sec.).	130	45	9	1,826	Apr. 7, 1918
Tonki Cape.....	Marmot Strait.....	White wooden house..	10	.....do.....	Flashing white (flash 0.3 sec., eclipse 2.7 sec.).	130	75	9	2,820	July 28, 1917

^a Discontinued Apr. 8, 1918.

SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER
GENERAL APPROPRIATIONS, COMPLETED DURING FISCAL YEAR 1918.

Station.	Cost.	Character of work.
FIRST DISTRICT.		
Stielman Rocks Beacon, N. H.	\$1,147	Purchased and set new iron spindle with day mark.
SECOND DISTRICT.		
Cape Cod Canal Range Lights, Mass.	1,857	Construction of, etc.
Cape Cod Canal Upper Range, Mass.	1,345	Stone riprap for protection.
Bakers Island Light Station, Mass.	1,401	Installing new oil engine in place of antiquated and worn-out engine.
Wings Neck Light Station, Mass.	5,271	Installing oil-engine outfit in duplicate, building fog-signal house, etc.
Pollock Rip Blue Light Vessel No. 73, Mass.	2,366	Docking, painting, repairs, etc.
Tender Asalea.	1,808	Do.
Do.	1,499	Docking, painting, etc.
Relief Light Vessel No. 66.	4,251	Installing new lantern gallery, making repairs to sheathing, repairing masts, installing new illuminating apparatus, etc.
THIRD DISTRICT.		
General Depot.	4,885	Purchase and installing electric elevator in north storehouse; raise grade of and lay concrete floor and rear-range chimney shed for a packing room.
New London Depot, Conn.	2,326	Dredging and removing 5,280 cubic yards of material around wharf.
Beavertail Light Station, R. I.	1,208	Reshingling with asbestos roof of dwelling and work-room, and made various repairs.
Borden Flats Light Station, Mass.	1,858	Built reinforced-concrete roof and pipe rail for main gallery and made various repairs.
Bristol Ferry Light Station, R. I.	1,301	Increased height of brick tower 6 feet; removed old wooden lantern, installed cast-iron lantern and deck, and made various repairs.
Bullock Point Light Station, R. I.	1,022	Removed old worn-out apparatus, and furnished and installed new fog-bell-striking apparatus.
New London Harbor Light Station, Conn.	1,165	Repointed walls, scaled and painted dwelling, whitewashed tower, and made various repairs.
North Hook Beacon Light Station, N. J.	7,272	Razed old light tower, 2 dwellings, and siren house; built 35-foot steel tower with electric light; built new siren house and installed siren; moved to new site, built foundation for, rearranged and repaired dwelling for 2 keepers, and made various repairs to station.
Stratford Shoal Light Station, N. Y.	1,038	Made and installed 2 cast-iron siren horns; purchased and installed repair parts for fog-signal engines.
Tender Daisy.	1,885	Purchased and installed surface condenser and circulating pump; docked vessel and repaired and painted hull; made various repairs.
Tender John Rodgers.	2,707	Docked vessel, scaled and painted hull; overhauled and repaired boiler, paddle wheels, and wheel-houses, also guards; recanvased upper deck and made various repairs.
Tender Larkspur.	1,128	Repaired boilers; made and installed two radiators in fore-castle; braced steering engine foundation; rearranged piping of water tanks; furnished and laid carpet in four rooms, and made various repairs.
Tender Pansy.	3,294	Removed wood rail and built new steel rail forward; renewed guard and guard angles forward; repaired guard aft; made and installed new ash ejector; furnished and installed new galley stove; made various repairs.
Tender Tulip.	5,293	Made 12 cast-steel propeller blades; overhauled and repaired boilers; docked vessel; repaired and painted hull and installed propeller blades; rearranged quarters to accommodate wireless apparatus; scaled and painted bunkers; built hanging shelves and supports in forward hold; made various repairs.
Scotland Light Vessel No. 11, N. J.	1,313	Docked vessel and repaired hull; furnished and installed new anchor; repaired bulwarks and rail and removed catheads; made various repairs.
Relief Light Vessel No. 16.	2,067	Docked vessel and repaired hull; renewed part of mooring chain; repaired and welded port hawse pipe; made various repairs.
Relief Light Vessel No. 20.	5,401	Built and installed lantern gallery on foremast and furnished and installed acetylene illuminating apparatus; repaired rigging of masts; docked vessel and repaired hull; rearranged afterlantern house and built tank cradles and supports; removed forward lantern house and repaired deck; painted "cross rip" on sides of hull; made various repairs.
Cornfield Point Light Vessel No. 48, Conn.	1,355	Docked vessel and repaired hull; repaired damage from collision on starboard side and stem; removed portable top and decked over afterlantern house; overhauled power-boat engine and made various repairs.

SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS, COMPLETED DURING FISCAL YEAR 1918—Continued.

Station.	Cost.	Character of work.
THIRD DISTRICT—continued.		
Relief Light Vessel No. 51.....	1,275	Docked vessel and repaired hull; repaired boilers; put 3 new valves in auxiliary steam pipes; made various repairs.
Fire Island Light Vessel, No. 68, N. Y..	1,028	Renewed 5 sections of smokestack and repaired guys; docked vessel and repaired hull; purchased new set of evaporator tubes; repaired power-boat engine and hull; renewed wearing stripe on starboard side; made various repairs.
Overfalls Light Vessel No. 69, Del.....	5,211	Furnished and installed acetylene illuminating apparatus on both masts; built tank houses aft; installed oak sheathing on both sides of hull; renewed part of mooring chain; repaired damage from collision to stern and life rail; made various repairs.
Relief Light Vessel No. 78.....	1,704	Docked vessel; repaired and painted hull; retubed and repaired both boilers; removed ash ejector and raised and reset filter box; built new skylight over galley; made various repairs.
Ambrose Channel Light Vessel No. 87, N. Y.	1,435	Docked vessel; repaired and painted hull; removed lead lining; removed and replaced rotten ceiling and repaired after lantern house; purchased new parts for and repaired air pump; made various repairs.
FOURTH DISTRICT.		
Fort Mifflin Bar Cut Range Rear Light Station, N. J.	1,308	A 34-order lens installed; illuminant changed from oil to electricity.
Fourteen Foot Bank Light Station, Delaware Bay, Del.	1,453	New revolving lens installed.
FIFTH DISTRICT.		
Annapolis Depot, Md.....	2,737	Repairs to pierhead and wharf.
Portsmouth Depot Annex, Va.....	2,120	Repairing and extending wharf.
Washington Wharf, D. C.....	3,000	Repairs to wharf.
Buoys.....	9,876	Altering 7 buoys to use compressed acetylene gas.
SIXTH DISTRICT.		
Charleston Lighthouse Depot, S. C.....	6,188	Installed power circuit; furnished and installed air-compressor plant and a shaper in lamp shop; and made some cinder fill for road foundation and grounds.
Jupiter Inlet Light Station, Fla.....	1,913	Installed water system consisting of a gasoline-engine-driven pump, a wooden tank on a steel tower, and distributing piping; repaired gallery rail of light tower; installed lightning conductor on tower and handrail on inside of tower.
Tybee Knoll Cut Range Light Station, Ga.	4,983	Raised tower on dwelling 16 feet and changed illuminating apparatus from a lens lantern to an oil reflector, using it for the rear instead of front light of range; constructed a new front range light on pipe tower on piles in front; constructed new boathouse and landing, tool house, and made general repairs.
Tender Cypress.....	8,000	Two dockings and general overhauling.
Tender Mangrove.....	1,148	Two dockings and minor repairs.
Frying Pan Shoals Light Vessel No. 94, N. C.	8,000	Two dockings and general overhauling.
Brunswick Light Vessel No. 84, Ga.....	2,878	One docking and minor repairs, also purchase of new condenser for main engine.
Relief Light Vessel No. 53.....	1,916	One docking and minor repairs; also installation of new circulating and air pumps.
Charleston Light Vessel No. 34, S. C....	1,534	One docking, renewing portion of metal sheathing, and minor repairs.
EIGHTH DISTRICT.		
Chefuncte River Range Front Light, La.	1,058	Rebuilding pyramidal structure on 4 iron-cased creosoted piles.
Galveston Jetty Light Station, Tex.....	11,633	Concrete block, 40 feet square around foundation piles and in places 10 to 15 feet in depth on northerly and southerly edges.
Heald Bank Light Vessel No. 81, Tex....	1,940	General repairs to hull and machinery.
Navy Yard Outer Bank Gas and Bell Buoy 19, Fla.	3,557	Establishment of gas and bell buoy.
Port Eads Depot, La.....	1,000	Entire new roof on one-half of depot building.
Tender Magnolia.....	10,557	General repairs to boilers, machinery, and hull.
Do.....	1,042	Renewing smokestack.
NINTH DISTRICT.		
San Juan Depot, P. R.....	4,170	The carpenter shop was rebuilt in reinforced concrete.
Anegado Range Rear, P. R.....	3,138	The old tower was erected on a concrete base in a new location.

SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS, COMPLETED DURING FISCAL YEAR 1918—Continued.

Station.	Cost.	Character of work.
TENTH DISTRICT.		
Buffalo Depot, N. Y.....	2,651	Constructed new launch No. 127.
Charlotte and Charlotte East Pier Light, N. Y.....	1,334	Installed electric generators with storage batteries to provide electricity for illuminant.
Galloo Island Light Station, N. Y.....	1,820	Constructed new launch No. 129
Rock Island Depot, N. Y.....	1,482	Repaired buoy wharf and derrick.
Sandusky Depot, Ohio.....	8,143	Rebuilt inner part of wharf; relocated boathouse, drove pile dolphin fenders, and replaced broken castings on several piles.
Tender Crocus.....	71,322	Provided and installed new boilers, rebuilt boat deck and restored vessel to working condition.
ELEVENTH DISTRICT.		
Thunder Bay Island Light Station, Mich.....	2,000	Reconstruction of landing dock, repairs to water supply and construction of walk to boathouse.
Brush Point Range Light Station, Mich.....	1,385	Riprap stone protection for front light structure.
Portage Lake Ship Canals East Breakwater Light Station, Mich.....	1,603	Moving of steel tower to a new location on the outer end of breakwater and making necessary alterations for installation of acetylene lighting equipment. Acetylene light installed.
Mendota Light Station, Mich.....	2,709	Construction of revetment along the water front where shore erosion was taking place rapidly; also short groins for shore protection purposes.
West Neebish Channel Lights, 17-18, Mich.....	3,200	Pile foundations for both lights were entirely reconstructed and the old lighting equipment reinstalled.
Tender Marigold.....	19,400	A new set of boilers were constructed by the Duluth Boiler Works, at Duluth, Minn.
Lake Huron Light Vessel No. 61, Mich.....	1,983	The framing of vessel, including deck and deck planking, forward of main hatch, was largely renewed. New tubes were installed in the boiler and other minor repairs carried out.
TWELFTH DISTRICT.		
Charlevoix Depot, Mich.....	1,095	200 feet reinforced concrete revetment alongside creek and brush and earth fill at east end of revetment; general repairs to warehouse and dwelling.
Racine South Breakwater, Wis.....	3,019	Establishment of acetylene light on 31-foot 6-inch standard steel tower on concrete base; marks outer end of south breakwater.
Ile aux Galets, Mich.....	1,214	Fog signal, old duplicate locomotive boilers removed and replaced with duplicate compact marine boilers; roof of fog-signal building reshingled; sundry repairs to station buildings.
Grand Haven Pierhead, Mich.....	1,737	300-foot metal elevated walk rebuilt; repairs to station buildings and grounds.
Green Island, Wis.....	1,744	West boat dock extended 16 feet, with superstructure of concrete; new metal boatway built; roof of dwelling reshingled; assistant keeper's quarters remodeled and improved; sundry repairs to station building, grounds, well, etc.
Racine Pierhead, Wis.....	9,100	Reinforced concrete sea wall placed around dwelling pier; new cellars built; space inside pier filled and graded; old workshop removed and a brick tool and work shop built on concrete foundation; miscellaneous repairs to dwelling and boathouse; post light established to mark stub end of north pier.
Manistique, Mich.....	1,765	Intensity of light increased by replacing 300 mm. lens lantern with a fourth-order lens; duplicate electric motor-drive air compressor installed; air-cooling coils placed.
Milwaukee Depot, Wis.....	1,019	Alterations and improvements to warehouse; yard derrick overhauled and reerected.
Tender Hyacinth.....	2,088	General repairs and overhauling of vessel's deck and engine departments.
Lansing Shoal Light Vessel No. 55, Mich.....	1,029	Docking and general repairs to vessel; incidental repairs to engine and machinery; planking through bolted through frames and ceiling.
Eleven-Foot Shoal Light Vessel No. 60, Mich.....	1,126	Docking and general repairs to vessel; overhauling and incidental repairs to fog-signal equipment.
Tender Sumac.....	6,742	New steel deck placed from bow aft to cargo hatch; new refrigerator, crew bath, and lavatory put in with steel framing and siding; both main boilers retubed; incidental repairs to vessel's upper works and machinery.

SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS, COMPLETED DURING FISCAL YEAR 1918—Continued.

Station.	Cost.	Character of work.
SIXTEENTH DISTRICT.		
Sentinel Island Light Station, Alaska....	1,890	Constructed hoist house; installed double-drum gas engine hoist for derrick and trams; provided and equipped bathrooms in quarters for keepers; made miscellaneous repairs to double dwelling, and miscellaneous alterations in fog-signal building.
Tender Cedar.....	3,103	Miscellaneous repairs and improvements.
SEVENTEENTH DISTRICT.		
Marrowstone Point Light Station, Wash.....	3,893	General repairs; moving and remodeling dwelling; installing sewer system, etc.
Warrior Rock Light Station, Oreg.....	1,842	General repairs and installation of modern plumbing, etc.
Salmon Bay Outer Light, Wash.....	1,361	Established acetylene light on dolphin.
Browns Point Light Station, Wash.....	4,400	Filling in swamp and grading grounds.
Columbia River Light Vessel No. 88, Oreg.....	2,256	Dry docking and general repairs.
Umatilla Reef Light Vessel No. 67, Wash.....	3,580	Do.
Tender Kukui.....	13,875	Do.
Tender Rose.....	1,375	Do.
Do.....	1,740	Steam steering-engine installation.
EIGHTEENTH DISTRICT.		
Humboldt Bay Fog Signal Station, Cal.....	2,172	Built timber bulkhead to protect shore from erosion by wash of sea in front of oil house and fog-signal building.
Oakland Harbor Light Station, Cal.....	1,336	Installing B air diaphone, electric motor, and compressor in place of bell.
Seal Island Light and Echo Board, Cal.....	1,018	5-pile beacon and echo board built and lens lantern installed.
Southampton Shoal Light Station, Cal.....	1,973	Installing C air diaphone, gasoline engine, and compressor in place of bell.
Tender Sequoia.....	3,328	Docking, cleaning, painting, repairs to hull, general overhauling, and repairing of boilers and machinery.
Tender Madrono.....	2,235	Docking, cleaning, painting, repairs to hull; general overhauling and repairing of boilers and machinery; new foremast installed.
Relief Light Vessel No. 76.....	4,466	Docking, cleaning, painting, and general repairs to hull and machinery; installed new evaporator.
Blunts Reef Light Vessel No. 83, Cal.....	3,965	Docking, cleaning, painting, repairs to hull; general overhauling of boilers and machinery, retubing star-board boiler; steam turbo-generator radio set installed.
NINETEENTH DISTRICT.		
Alla Point Light Station, Hawaii.....	6,156	Discontinued lens lantern light; erected 72-foot skeleton steel tower with reinforced-concrete tank house; furnished, installed, and placed in operation a 375-mm. gas-lighted lantern and equipment.
Kauhola Point Light Station, Hawaii.....	1,110	Discontinued old lens lantern light and erected temporary frame tower; installed a fourth order flashing lens with incandescent oil-vapor lamp, all of which was on hand at the depot; placed new light in operation.
Hanamania Light Station, Hawaii.....	3,007	Erected reinforced-concrete tower; furnished, installed, and placed in operation a 300-mm. gas-lighted lantern and equipment; erected wooden derrick for landing accumulators from boat.
Diamond Head Light Station, Hawaii.....	6,109	Dismantled the old tower with watchroom and lantern carried on temporary support; erected new reinforced-concrete tower up to and including watchroom deck; provided new cast-iron spiral stairway and made repairs and improvements to the watchroom lantern.
Honolulu Harbor Channel Light No. 4, Hawaii.....	1,470	Discontinued the old 3-pile wooden structure and erected a 3-pile reinforced-concrete structure in new location.
Honolulu Channel Range Front and Rear Lights, Hawaii.....	1,293	Established two electric incandescent range lights; front light on wharf shed roof, rear light on skeleton steel tower on roof of office building.
Walhee Reef Gas Buoy, Hawaii.....	2,256	Discontinued former Walhee Reef Whistle Buoys and established gas buoy in its place.
Lighthouse Wharf, Honolulu.....	1,553	Erected 20 by 30 foot wharf extension and 2 dolphins at lighthouse wharf for accommodation of the tender and the handling of buoys.

REPORT
OF THE
SUPERINTENDENT, U. S. COAST AND GEODETIC
SURVEY

97796°—COM 1918—41

641

REPORT

OF THE

SUPERINTENDENT, U. S. COAST AND GEODETIC SURVEY.*

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, October 5, 1918.

SIR: There is submitted herewith my annual report as Superintendent of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1918. This is the eighty-seventh annual report of this Bureau.

INTRODUCTION.

In this annual report the same plan of division and discussion is followed as in the annual report for the fiscal year ended June 30, 1917, with the exception that it contains an added chapter on the war work of the Bureau.

In Part I, Chapter I, is a discussion of the field accomplishments of the Bureau during the year. In Chapter II is a statement of the needs of the Bureau to better accomplish its field work.

In Chapter I of Part II is outlined what has been done in the Washington office of the Bureau during the fiscal year, and in Chapter II of Part II are pointed out some of the needs of the Washington office. Chapter III of Part II contains a statement of the activities of the Bureau in connection with the war.

In Part III is given a résumé of the work accomplished in the field and office during the year.

* Thirty-seven illustrations appeared in the pamphlet edition of the Superintendent's report, but are omitted from this volume.

Part I.—FIELD WORK AND NEEDS OF THE FIELD SERVICE.

CHAPTER I.

WHAT HAS BEEN DONE DURING THE FISCAL YEAR.

In the report of this Bureau for the fiscal year ended June 30, 1917, were shown in the main the characteristics of the coast lines of the United States and possessions, under four general classifications, and this was followed by a detailed statement of the conditions and progress of the hydrographic surveys up to that time. (See pp. 8 to 41, inclusive, of the Report of the Superintendent of the United States Coast and Geodetic Survey for the year ended June 30, 1917.) It is unnecessary to repeat here the discussion in that report, except so far as it relates to the hydrographic work accomplished during the present fiscal year, but it is referred to, as it contains a statement of the hydrographic problem before the Survey and will lend assistance in considering the relation of the hydrographic work done during the fiscal year to what yet needs to be done.

Considered from the standpoint of units of classification, the field work accomplished by the Bureau during the fiscal year ended June 30, 1918, is best expressed as follows:

Hydrography: (1) Ship and launch hydrography, (2) wire-drag surveys, (3) revision work, (4) current observations, (5) tidal observations, and (6) topography.

Geodesy: (1) Triangulation, (2) precise levels, and (3) magnetic observations.

HYDROGRAPHY.

1. *Ship and launch hydrography.*—The vessels of the Bureau in commission within the year were as follows: *Surveyor, Bache, Isis, Matchless, Hydrographer, Patterson, Explorer, Yukon, Taku, Pathfinder, Fathomer, Marinduque, Research, and Romblon.*

The *Surveyor, Bache, and Isis* were requisitioned by the Navy Department as auxiliaries to the naval fleet, and taken over by Executive order on September 24, 1917. From that time throughout the fiscal year they have been under the control of the Navy Department.

The *Explorer* was on field duty only during the first month of the fiscal year, the *Patterson* from the beginning of the year to the close of September 23, and the *Taku* less than a month. During 1918 the Navy Department felt the need of additional vessels to patrol the waters of the Pacific coast, and on May 16, 1918, the *Patterson*, now the U. S. S. *Forward*, and the *Explorer* were transferred to the naval fleet by Executive order. The surveying seasons of the *Explorer* and *Taku* were necessarily prematurely closed because of the mutiny and desertion of their crews, and the *Patterson, Explorer, and Taku* were not sent to the field in the spring of 1918, because of the lack of officers and the difficulty of enlisting crews owing to labor conditions.

The form of enlistment under which seamen are employed on the vessels of this Bureau amounts to no more than a civil contract, and this form of enlistment is as favorable as can be drawn for the Government under the present laws. Under normal conditions, when there was no keen competition for seamen, this enlistment served the purpose of the Bureau very well, though even then if a sailor chose to desert there was no recourse but to give him an "unfavorable discharge." As the demand for skilled labor has grown under present war conditions, the weakness of such a form of enlistment has become more and more evident. Employment on a vessel of the Coast and Geodetic Survey is not looked upon with as much favor by seamen as is employment on a vessel of the merchant marine, for the reasons that employment on a vessel of the merchant marine may be continuous, while on a vessel of the Coast and Geodetic Survey on the west coast it is only during the surveying season, with the certainty that at the termination of the season the employment ends at least for months. The duties required to be performed by a seaman on a merchant-marine vessel are less exacting than on a vessel of the Coast and Geodetic Survey. A seaman on a merchant-marine vessel receives overtime pay for overtime service, while such a condition of employment is impracticable on a Government vessel. I have presented this matter of enlistment of seamen on vessels of the Coast and Geodetic Survey more in detail under the head of "Needs of the field service" in another chapter, and hope that the requisite legislation may be enacted which will make possible an enlistment of seamen on the vessels of the Coast and Geodetic Survey that will insure adequate service.

Of the five vessels that have been in use by this Bureau in the surveys of the waters of the Philippine Islands, four belong to the insular government, namely, the *Fathomer*, *Marinduque*, *Research*, and *Romblon*. The officers of these four vessels were of the technical force of this Bureau. When the need became manifest for men with the technical qualifications of the officers of the Coast and Geodetic Survey in the Army and Navy in the prosecution of the war, more than half of this technical force was transferred to the military branches of the Government by Executive order, as authorized by section 16 of the "Act to temporarily increase the commissioned and warrant and enlisted strength of Navy and Marine Corps, and for other purposes," approved May 22, 1917. This necessitated the withdrawal of a number of these officers from service on the vessels loaned by the insular government. In view of this shortage of officers and the fact that the *Research* had practically completed the survey of all sheltered waters where it was safe for her to go, and further on account of her age and weakened condition it was unsafe to send her to survey exposed waters, she was turned back to the insular government the latter part of December, and the *Marinduque* was transferred back temporarily to the insular government on March 19, 1918.

1. The *ship and launch hydrography* performed during the fiscal year was as follows:

Sewall Point, Va.: 3 square statute miles. This survey was asked for by the Navy Department. It was accomplished in small boats and may be classed as launch hydrography.

Pamlico, Croatan, and Roanoke Sounds, N. C.: 395 square statute miles. This is in completion of revision surveys of these sounds, the need of which was cited in my annual report for 1917, on pages 27 and 28. This work was accomplished in launches and pulling boats.

York River, Va.: 4.5 square statute miles. The surveys in the York River, Va., were made at the request of the Navy Department. This was all launch work.

Mississippi Sound and Mobile Bay: 1,690 square statute miles. The need of this and other surveys along the Gulf coast is shown on page 32 of my report for 1917. About half of this work may be classed as ship hydrography and the remaining half classed as launch hydrography.

Chesapeake Bay: 35 miles of soundings, all ship work.

Approaches to Cross Sound, Lisianski Inlet and Strait, Alaska: 2,317 square statute miles. About seven-eighths of this work may be classed as ship hydrography. The remainder was launch hydrography.

Northward from Cape Muzon, Alaska: 8.8 square statute miles. About two-thirds of this work may be classed as ship hydrography. The remainder was launch hydrography.

Prince William Sound, Alaska: 32 square statute miles, all launch hydrography.

Approaches to Burdeus Bay, Polillo Island, north coast of Polillo Island, and Cuyo Islands, P. I.: 1,516.5 square statute miles. About seven-tenths of this work was done by the vessel and the remainder by launches.

West coast of Busuanga Island, P. I.: 2,443.6 square miles. Nine-tenths of this was done by the ship and the remainder by launches.

Southeast coast of Palawan Island, P. I.: 1,312 square miles. About half of this was done by the ship and half by launches.

East coast of Palawan Island, P. I.: 1,134.4 square statute miles. About half of this was done by the ship and half by launches.

Manila Bay, P. I.: 315.5 square statute miles. About nine-tenths of this was done by the ship and the remainder by launches.

2. *Wire-drag surveys.*—There were five wire-drag parties in the field within the year. For purposes of identification they were given designation numbers.

Wire-drag party No. 1 operated in the approaches to Portsmouth Harbor, N. H., and in the vicinity of Block Island. This party was in the field from July 1 to September 27, 1917, and from May 6 to June 30, 1918. Ninety-seven square statute miles were dragged.

Wire-drag party No. 2 operated in Block Island Sound, Narragansett Bay and approaches, Long Island Sound, and vicinity of Eastport, Me. The party was in the field from July 1 to November 27, 1917, and from May 7 to June 30, 1918, and covered 167 square miles.

Wire-drag party No. 3 operated in Frederick Sound and Cook Inlet, Alaska. The party was in the field from July 1 to September 28, 1917, and from May 3 to June 30, 1918, and covered 230.2 square miles.

Wire-drag party No. 4 operated in the vicinity of Juneau, Alaska. The party was in the field from July 1 to September 11, 1917, and covered 72.7 square miles.

Wire-drag party No. 5 operated in the vicinity of Dry Tortugas, off the southern coast of Florida. The party was in the field from July 1 to September 29, 1917, and covered 140 square miles.

3. *Revision work*.—Revision work was done in the localities named below:

Plymouth, Mass.: 217.5 miles of sounding lines run.

Buzzards Bay, Mass.: 5 miles of triangulation and 3 square miles of hydrography.

South shore of Long Island Sound: 11 triangulation stations occupied, 34 miles of shore line run, and 27.5 miles of railroads and other roads.

Vicinity of Seattle, Wash., Lake Washington Ship Canal: 3 triangulation stations occupied, 14½ square miles of topography and 3.75 square miles of hydrography completed.

4. *Current observations*.—The following are the general localities of the principal current observations made during the year and the number of stations occupied at each of these localities:

Locality:	Number of stations.
Block Island Sound.....	7
Coast of Maine.....	7
Hampton Roads, Va.....	1
Long Island Sound.....	26
Port Jefferson, N. Y.....	2
The Race, Long Island Sound.....	4

5. *Tidal observations*.—Tidal observations were made throughout the year at the following permanent tidal stations:

- | | |
|-------------------------|-------------------------|
| 1. Portland, Me. | 8. Key West, Fla. |
| 2. Fort Hamilton, N. Y. | 9. Cedar Keys, Fla. |
| 3. Atlantic City, N. J. | 10. Galveston, Tex. |
| 4. Philadelphia, Pa. | 11. San Diego, Cal. |
| 5. Baltimore, Md. | 12. San Francisco, Cal. |
| 6. Fernandina, Fla. | 13. Seattle, Wash. |
| 7. St. Augustine, Fla. | 14. Craig, Alaska. |

Important tidal observations were made at the following stations:

- | | |
|--------------------------|--------------------------|
| 1. New London, Conn. | 7. Petersburg, Alaska. |
| 2. New Haven, Conn. | 8. Canoe Cove, Alaska. |
| 3. Port Jefferson, N. Y. | 9. Miner Island, Alaska. |
| 4. Gloucester Point, Va. | 10. Auke Bay, Alaska. |
| 5. Pascagoula, Miss. | 11. McClure Bay, Alaska. |
| 6. Bay St. Louis, Miss. | 12. King Cove, Alaska. |

6. *Topography* in connection with hydrographic work was executed as follows:

Narragansett Bay and east end of Long Island Sound: 41.3 square miles.

Sewall Point, Va.: 1 square mile.

North Carolina sounds: 15 square miles of topography, 71 miles of shore line, and 18½ miles of railroads and other roads surveyed.

Mississippi Sound and Mobile Bay: 140 square miles of topography and 194.5 miles of shore line.

Cross Sound, Alaska: 32 square miles.

St. Thomas, Virgin Islands: 10 square miles.

Prince William Sound, Alaska: 40 square miles.

Stephens Passage, Alaska: 14.9 square miles.

Frederick Sound, Alaska: 126.25 square miles.

Coast of Alaska north of Cape Muzon: 10.5 square miles.

Knik Arm, Alaska: 2 square miles.

East coast of Palawan, P. I.: 57 square miles.

Burdeus Bay, P. I.: 32.5 square miles.

Southeast coast of Palawan, P. I.: 45 square miles.

Manila Bay, P. I.: 47.2 square miles.

Northwest coast of Busuanga, P. I.: 4.5 square miles.

GEODESY.

1. *Triangulation.*—Primary triangulation was accomplished in the following localities: Along the Rio Grande in Texas and in the vicinity of Stephens Passage and Lynn Canal, southeast Alaska. The total extent of this triangulation is 639 miles. Primary traverse was carried on in the following localities: Mostly in Georgia but also in South Carolina and Virginia. The extent of this traverse is 940 miles. Tertiary triangulation was executed in the following locality: Along the Cape Fear River in North Carolina. The extent of this tertiary triangulation is 70 miles.

2. *Precise levels.*—During the year 2,367 miles of precise levels were run as follows: In Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, and Virginia.

3. *Magnetic observations.*—In the continuation of the magnetic survey of the United States, observations were made during the year at 275 stations in 21 States, of which 118 were new primary stations. 114 auxiliary stations, 34 repeat stations for the determination of secular change, and 9 new stations in old localities. Meridian lines were established when they were requested by the local authorities. The number of county seats at which magnetic observations have not been made was reduced from 163 to 138.

The observatories at Cheltenham, Md.; Vieques, P. R.; Tucson, Ariz.; Sitka, Alaska; and near Honolulu, Hawaii, were in operation throughout the year. Continuous photographic records were secured of the variations of declination, horizontal intensity, and vertical intensity. Absolute observations were made at least once a week and scale value determinations once a month. Beginning with January, 1918, horizontal intensity observations as well as dip and declination were made both in the morning and in the afternoon on the same day to secure additional data regarding the relation between the variation and absolute instruments.

CHAPTER II.

NEEDS OF THE FIELD SERVICE.

SURVEYING VESSELS.

In my report for last year there was given a specific and detailed statement so far as information was available regarding the progress and condition of hydrographic surveys of all the waters contiguous to the United States and possessions, and incidental to this a discussion of the various classes of hydrographic surveying.

The most costly class of hydrography, and from many points of view the most important, is ship hydrography. There are thousands upon thousands of square miles of this class of hydrography that should be executed without further delay. These are areas removed from the sight of land, exposed waters in extensive bays and sounds, and waters of those regions nearer shore where there is no refuge for smaller craft, relatively costly because of the large unit of organization that is required to perform the work. On the other hand, the results obtained can be secured in no other way and by no other means, and are of the utmost importance to maritime commerce, and in many instances the development of industries is actually retarded or prohibited because of the lack of these surveys.

Alaska presents the most striking example of this state of affairs. The latent commercial possibilities of this great Territory have been but little exploited, and the natural resources of the country in the way of the known vast deposits of coal, copper, etc., lay dormant largely because the country is commercially only accessible through her waterways, and these are but meagerly surveyed. Charts of these waters are issued continually, which from the nature of their origin are known to be indifferent approximations of what should be represented. They are of many important regions, mere compilations from surveys dating as far back as the time when Russia owned the territory, from incidental soundings by fishing schooners and other vessels that venture into unsurveyed waters, and from soundings by other Government vessels venturing into these waters on other missions. Such charts may be in many instances worse than useless to the navigator, because they lend assurance where danger lurks and purport to guide the navigator to safety where if he escapes destruction it results more from chance than from representations on the chart. And even the charts that are issued of many localities are void of information because no official surveys have been made by the Government, and no official examinations have been made by other agencies.

This lack of adequate surveys is keenly felt by the shipping interests that risk their vessels in Alaskan waters. There are regions where industries are awaiting development, where these companies will under no consideration send their vessels because of the unknown dangers, and this caution is grounded on experience such as is shown

by a letter received from the general manager of the Pacific Steamship Co., under date of May 2, 1918, wherein he says, in part:

At the present moment the Pacific Steamship Co. has two passenger steamers in trouble in southeastern Alaska as the result of unavoidable strandings. First, the *Admiral Evans*, which struck an uncharted rock in the entrance of Hawke Inlet, as a result of which it was necessary to beach her immediately, where she now lies with her stern in 11 fathoms of water. Thirty days' salvage operations have failed of results, and the best we can hope for is the loss of the use of the vessel for six months, and a total expense of from \$300,000 to \$400,000 for recovery and repairs. After the accident a Survey vessel was sent to the spot and discovered and buoyed the rock, thus adding one more expensive unit to the accidental survey of Alaskan waters.

Our S. S. *Admiral Farragut*, while steaming north from Petersburg on April 28, struck an unknown obstruction, but where the chart showed 3 and 3½ fathoms of water, and the tide one hour to go, with the vessel drawing 19 feet and 6 inches aft, probably not over 16 feet forward. Her Nos. 1, 2, 3, and 5 tanks are leaking. The pumps were able to keep her afloat until she arrived at Juneau, where she is now discharging cargo, and it will undoubtedly be necessary to bring her to Seattle for extensive repairs. I understand some of the Coast and Geodetic Survey people were aboard the *Admiral Farragut* when she struck, and you will probably be apprised of the details.

Here the loss to a single company operating steamers in Alaskan waters, in two instances, has been in excess of the entire appropriations for the Coast and Geodetic Survey by this Government for the current year for surveying the waters of Alaska, Washington, Oregon, California, the Philippine Islands, and Hawaii, and the yearly loss of vessels in the unsurveyed waters of Alaska alone would go far toward supplying vessels sufficient to make the necessary surveys to aid and assist commerce in these waters, but which should certainly now be expedited when commerce is pushing its way into these waters regardless of the lack of surveys, and paying the price in a loss of ships and cargoes that averaged \$490,300 annually during the 10-year period from 1906 to 1915, inclusive.

While the great stretches of unsurveyed or inadequately surveyed waters bordering the coasts of the Territory of Alaska present a most striking example of the retardation of a country's commerce and development, which could be stimulated to return a profit far in excess of the cost of proper surveys, this is not peculiar to Alaska alone. Ship-borne commerce is traversing the waters of some of the coasts of continental United States and escaping destruction more through the experience and knowledge of the navigator than by the guidance of charts that contain all the information that is necessary. The general surveys of the coasts of Washington were made between 1873 and 1894, of Oregon between 1868 and 1891, and of California between 1858 and 1901. These surveys were, for most of the sections of the coasts, in the nature of reconnaissance, and extended in but few instances beyond the 100-fathom curve, and indeed in some instances between the 50-fathom curve and the 100-fathom curve the charts are void of information. It was fully realized at the time that this survey must later be supplemented by other work, but the then pressing needs demanded a general knowledge of all waters of the coasts rather than definite knowledge as to a selected part and no knowledge as to the remainder. Therefore, the whole coast was covered by a quite general survey. Figure 5^a affords a tangible illustration of the scant information that the resulting chart contains. The acquisition of Alaska in 1867 with her thousands of miles of shore line placed before the Bureau a task that its facilities have

^a Not included in this compilation.

never since been expanded to meet, and with the exception of fragmentary examinations here and there, supplemented by information of doubtful value accepted from unofficial sources, the charts of the coasts of Washington, Oregon, and California have been issued year after year which could contain only the data obtained from the above-mentioned reconnaissance surveys.

It might be urged that since 50 fathoms (300 feet) afford depth of water in which no vessel has a draft such that it will ever run afoul of the bottom, there is no apparent need of surveys of waters of greater depth. Based on the necessary depth for the draft of a vessel this is true, but a knowledge of the depths is essential to the navigator from a wholly different point of view, namely, that of assisting navigation.

The prevailing weather along the coasts of Washington, Oregon, and California is in nautical language "thick"; that is, heavy fogs are the rule. A vessel from San Francisco to Puget Sound may be for hours, or even throughout the trip, hidden in a mist that obscures land and sky. Under such circumstances the master judges the location of his vessel by the distances and direction he has run as shown by the speed of his engines, the time that has elapsed since leaving a known position, and his direction by the compass. There are other factors that may contribute to place a vessel in a position entirely different from that which would result from calculations based on the above elements. The currents of the waters adjacent to the Pacific coast line of the United States vary both in direction and strength and observations have not yet been made sufficient to predict these currents. These currents may retard or accelerate a vessel, or carry her toward or from the land, and after steaming for hours through a thick fog, a vessel that according to reckoning from speed and direction taken may be at the position according to her course as plotted on the chart or dangerously near destruction by running ashore. Under these circumstances a chart that showed depths out to the thousand-fathom curve would be of undeniable value. Given all the characteristic depths of the waters along the coasts out to the thousand-fathom curve, a navigating officer is nearly as well guided as is a citizen in a city by the names of the streets on the lamp-posts.

It is essential that surveys be extended out to the 1,000-fathom depths in order that we may be reasonably sure that no undiscovered shoal areas exist, which if found by the navigator might be mistaken for shoal areas already shown on the chart and thus lead him astray.

The examination of any chart where a close survey has been made will show from the varying depths that in but few places is the bottom of the ocean plane, but, on the other hand, is undulating, or may drop off to abrupt depths where there are underwater banks that correspond to the bluffs along a river or the seashore. Below moderate depths and the influence of waves and strong currents (probably below 50 fathoms) the topography of the ocean bed remains fairly constant. With then a chart showing these details out to the thousand-fathom curve, a vessel could proceed from San Francisco to Seattle, though engulfed in a dense fog throughout the journey, with assurance of the position as judged from the course run and checked by soundings, for though the vessel was thrown

off her course by adverse currents, this would at once become apparent by the soundings showing depths different from those shown on the chart at the supposed position of the vessel, and it would be only a matter of further sounding and comparison of depths indicated on the chart to estimate the position of the vessel, for it is to be remembered that though other influences may vary, as the speed of the engine, the direction of the compass, and the direction and velocity of the currents, yet the depths when once known, below comparatively shallow ones, remain constant and are a sure guide. The assistance that known depths afford the navigator and how he may be misled by unknown depths are shown by figure 6.^a

Reference has been made above to the currents of the Pacific coast. The general conception of a hydrographic survey is one that develops the depths of the water and discloses the nature of the bottom, but the direction, strength, and time of ebb and flow of the currents of the Pacific coast of the United States are quite as important as is other nautical information, mainly because of the heavy fogs that hang over these waters making it necessary to determine the position of a vessel after hours of progress by taking into consideration all the known elements that may have influenced her position up to the time that it is desired to know her position. On the Pacific the ocean currents, mainly from lack of proper observations over a sufficient period, have so far eluded any exact estimate of their influences. A theory has long been held, and from which there is but little doubt, that practical results of the utmost value will be obtained from continuous observations taken for the Coast and Geodetic Survey from light vessels which are stationed at positions that present points of peculiar vantage, and from the information thus gained at least general predictions could be made that would be of material assistance to navigators.

While Alaska is suffering loss of shipping and her development retarded from the lack in some regions of any surveys and the Pacific coast of the United States is in need of more complete surveys, there is yet one other condition that must be met by the Coast and Geodetic Survey in order to keep the information current on the charts that are issued. This condition is aptly illustrated by the sandy formation beneath the waters adjacent to Cape Cod. Here is a section of the coast (and it is characteristic of many others) where a complete hydrographic survey may show the depths at the time the survey is made and be absolutely in error after a severe storm, should one occur directly after the completion of the survey, or it may be accurate for months, depending wholly upon how the loose sand forming the bottom may be shifted. It is difficult to draw the line as to just how often and how thorough surveys should be made of such localities, but certain it is that where the value of the vessels lost is equal to or in excess of the cost of proper surveys can be attributed to lack of information as to existing conditions, then, to this extent at least surveys should be made. And the vessels that are lost in such waters are not so small in number or value. The New England Fisheries, printed at Boston, Mass., is authority for the statement that along 40 miles of Cape Cod shore 592 vessels have been lost during 50 years, giving specifically the names of the vessels and dates of their loss. Figure 7^a, reproduced from that publication, shows the positions where these vessels were lost.

^a Not included in this compilation.

It would be erroneous to assume that all these vessels or even a considerable proportion of them were lost because the Government charts lacked information they should have contained, or contained inaccurate information, but, on the other hand, it can not be asserted, in view of the known fact that changes occur in such localities oftener than surveys are made, that some of these vessels were not led to destruction by risking the shorter inside route where favorable depths that might not have existed at the time were shown on the charts, rather than taking the longer outside course.

The shifting sandy bottom around Cape Cod is but one example of such conditions. Wherever there is a combination of sandy bottom in waters of moderate depths and prevailing strong currents, or severe storms that cause strong currents, the depths over these areas do not remain constant, and continuous examinations are necessary. That these changes are more rapid beneath the waters to a depth not in excess of wave and current effects than above the surface of the water is beyond dispute, yet they are quite marked even above the surface of the water, instances of which are noted in the annual report of this Bureau for 1917, wherein it was shown that the shore of Rockaway Inlet has advanced $3\frac{1}{4}$ miles in 79 years, and that the sand spit that forms the protection for Assateague anchorage is being extended at the rate of 200 yards a year.

These then are the conditions that form the three prime requisites for additional vessels for the Coast and Geodetic Survey; a matter that should have the earnest consideration of all parties interested in affording reasonable protection to the safety to commerce and human lives that are carried upon the waters over which the Bureau is responsible for charts bearing proper data.

The totally unsurveyed areas in Alaskan waters should certainly have immediate attention that commerce between that country and the outside world may be quickened; the incompletely surveyed waters of the three Pacific Coast States from which the surveying vessels of the Bureau were diverted to Alaskan waters on the purchase of that Territory (with a coast line greater than the whole continental United States) ought to be closely examined out to the thousand-fathom curve so that vessels aggregating in value far in excess of the cost of needed surveys will not be lost on account of insufficient data; and, finally, examinations should be made to the extent that the benefits are justifiable in comparison with the cost of surveys of those waters frequented by marine commerce where strong currents and severe storms shift the shore lines and the contour of the sea bottom.

A common-sense consideration of whether or not the Coast and Geodetic Survey is now supplied with a sufficient number of surveying vessels, and if not, what the required number is, must, it would seem, lead to a determination of some standard which shall be the measure of the proper completeness of surveys. It is obvious that it would be folly to have no Government or other surveys and leave the master of a vessel to seek his way without a chart from which to select his course and without aids to navigation to warn him of danger. On the other hand, it is conceded that Government surveys could be carried on to such an extent of completeness and minuteness that the cost would be wholly disproportionate to the benefits gained. Between these two extremes there must be a mean

that shall determine the standard of completeness of surveys, and while this mean can not be defined with exactness, it is sufficient to say that where the cause of the loss of vessels of a value in excess of the cost of proper surveys can reasonably be attributed to the lack of proper surveys, then, and to that extent at least, vessels should be provided for making proper surveys.

Measured by this standard, the Coast and Geodetic Survey has not now, and has not had for years past, enough surveying vessels to keep pace with the needs of maritime commerce.

I have already cited the fact that there are vast water areas along the coasts of Alaska where no hydrographic surveys have been made and other areas where the charts are based on soundings of Russian origin, and that to this day the charts of important waters adjacent to Washington, Oregon, and California are issued showing the results of little more than preliminary surveys made years ago. This is a state of affairs that now ought not to be. Vessels are being lost in these waters year after year of a value far in excess of the cost of surveying vessels for making proper surveys, to say nothing of the human lives that are also lost, and the loss of some of them at least can be attributed to the lack of proper surveys. I showed in my report for 1917 how the *Bear* was a total loss just north of Cape Mendocino through the master being misled by lack of information on the chart, and I have quoted earlier in this report a letter from the general manager of the Pacific Steamship Co. to the effect that two vessels of that company had come to grief, entailing a loss of hundreds of thousands of dollars. It is needless to burden this report with other similar citations.

I know of no better way to sum up the situation than by comparing the area surveyed by the vessels of the Coast and Geodetic Survey in the waters of the three Pacific Coast States and Alaska during one year with the total area of these waters that remains to be covered by surveys that can not be made by other than surveying vessels. In making this comparison it would be unfair to use the area covered by these vessels during the fiscal year ending June 30, 1918, because conditions were not normal in that some of the surveying vessels were unable to do a full season's work as men to man the vessels were unobtainable, and further because two of the surveying vessels were during the year taken over by the Navy Department. I shall therefore use as a basis of comparison the areas covered by the surveying vessels in these waters during the fiscal year ending June 30, 1917, which was a normal year. The table below gives a summation of the areas covered by the different vessels:

Name of vessel.	Field of operations.	Area covered, in square statute miles.
Explorer.....	Richs Passage, Washington.....	0.5
Do.....	Cape Muxon, Alaska.....	574
Do.....	Dall Island, Alaska.....	209
Patterson.....	Kashevarof Islands, Alaska.....	90
Do.....	Cross Sound, Alaska.....	5.9
Taku.....	Orca Inlet and Copper River, Alaska.....	111.5
	Oregon.....	None.
	California.....	None.
Total.....		990.90

The total area in square statute miles of waters adjacent to Alaska, Washington, Oregon, and California that can not be surveyed by other than vessels of seagoing size, and of which surveys are immediately necessary to make navigation safe, is as follows:

Alaska	587, 000
Washington	11, 500
Oregon	15, 200
California	35, 400
Total	649, 100

The conclusion is inevitable that if these conditions are going to be remedied more surveying vessels must be put into the field in these waters to bring these surveys up to a standard of completeness where the value of the vessels lost yearly through the lack of proper nautical information will not be so entirely out of proportion to the cost of vessels to make proper surveys. And the wisdom of such a move is the more evident when it is considered that vessel for vessel the cost of a surveying vessel is usually but a fractional part of the cost of the merchant vessel that is lost. This is because a freight vessel to be operated with profit must be of several thousand tons displacement to have the most economic carrying capacity, while the most effective surveying vessel is of but about a thousand tons displacement.

The thought may arise that since surveys are so badly needed of the waters adjacent to Alaska, Washington, Oregon, and California, it might be well to withdraw vessels from other waters, such as the Atlantic coast or the Philippines to make these surveys. The Atlantic coast where such conditions exist as abound in the vicinity of Cape Cod, for example, is just as sorely in need of vessels to make necessary surveys as is the Pacific coast.

Proper surveys of the waters adjacent to the Philippine Islands are to-day more advanced than of any other Pacific coast waters over which this Bureau has jurisdiction, but this is because vessels for making surveys, with the exception of one, were furnished by the insular government, but as they belong to the Philippine Islands they can not be withdrawn to other waters.

There is one other consideration that has not yet made its effect felt through direct application, but which should have the greatest weight in connection with this problem, and that is, that in the past many of the vessels that have frequented our waters and which have been subject to danger through lack of proper surveys have been of foreign register, but with the great advance in shipbuilding in this country our own money invested in our own ships will of necessity in the future be subjected to this danger of loss, and it is good business to look to the future and consider that the cheapest form of marine insurance is to spend a few thousands of dollars for vessels to make proper surveys rather than lose many thousands or millions of dollars and also human lives in vessels lost through lack of proper surveys.

It is of the utmost encouragement to record that since the above was written an act has been approved authorizing one standard size and one smaller surveying vessel for the Coast and Geodetic Survey. This is heartening, and with these modern vessels much can be done

to relieve the situation in the Pacific coast waters, but the disparity between what can be done when these vessels are added to the fleet of the Coast and Geodetic Survey and what remains to be done is so great that the surveying fleet must still be augmented to bring our hydrographic surveys up to the standard of completeness that should prevail in order that navigation can be reasonably safeguarded.

WIRE-DRAG LAUNCHES.

While surveys of water areas removed from the sight of land, exposed waters in extensive bays and sounds, and waters in those regions nearer the shore where there is no harbor for smaller craft to seek refuge during storms must necessarily be made by stanch surveying ships, there is another class of hydrographic surveys that can only be made with special power launches and special equipment—the wire-drag survey.

This is the only method of making effective surveys where from the soundings with the lead and line the prevailing depths are found to be in excess of the needs of navigation, and yet there may be between the soundings taken with the lead and line an obstruction sticking up from the bottom of the sea to within a few feet of the surface and which would damage or wreck a vessel that struck it.

Such an obstruction may be one of the isolated boulders that are so frequently found in the waters of the coasts of the New England States, or one of the reefs of coral formation adjacent to the coast of southern Florida, Porto Rico, the Hawaiian Islands, Guam, or the Philippine Islands, or it may be one of the needlelike (pinnacle) rocks that stick up to unusual heights (sometimes 400 to 500 feet) from the bottom of the sea in the waters of southeastern Alaska.

Such obstructions as these, hidden beneath the water, could hardly be found if there were no other means than by sounding for them with a hand lead, if it were known exactly where the obstructions were, and much less would this be probable if a needlelike rock were sticking up from a depth of 407 feet, somewhere in an area 3 miles wide and 6 miles long, such as the area north of Vank Island at the eastern end of Sumner Strait in southeastern Alaska.

To find these isolated boulders, coral reefs, and pinnacle rocks the wire drag must be used, which, without going into technical details, is substantially a strand of wire supported in a horizontal position about 30 feet beneath the surface of the water by floats and held down by sinkers, and the whole pulled through the water by power launches. Thus, any obstruction sticking up from the bottom of the ocean less than 30 feet from the surface of the water is caught by the horizontal wire as it is drawn through the water and its position is indicated by the place in the wire where it becomes engaged, on much the same principle that a rope if drawn along the ground by two men, one at each end, in a direction at right angles to its length, would be caught on any obstruction sticking above the smooth surface of the ground over which the rope was dragged, such as a tree stump, and the angle that the rope would form when caught by the tree stump and pulled taut by the men would indicate the position of the tree stump. While this crudely illustrates the main principle of the wire drag, it has been developed into a highly capable and most effi-

cient instrumentality for discovering those isolated boulders, reefs, and pinnacle rocks that elude the efforts to find them with the lead and line.

While 30 feet was mentioned as the depth at which the horizontal wire is drawn through the water, it may be adjusted to any desired depth by an ingenious arrangement on the floats to which the vertical strands of wire supporting the horizontal wire are attached. In fact, by close study and by practical experience, every unit that goes to make up a wire drag has been developed to the highest degree of efficiency. To this there is one exception, and this exception is the principal handicap to rapid and economical wire-drag surveys at the present time.

This exception is that the Government has not owned the power launches that pull the wire drag through the water, nor has the Coast and Geodetic Survey funds which can be expended for the purchase or construction of suitable launches. There are certain fundamental features requisite so that such a launch will be efficient, and these features are not common to launches that can be rented for making these wire-drag surveys, though the requisites are approximated as nearly as those available for hire will permit. Pleasure launches, while they have the speed, are too frail of construction to stand the strain of pulling the wire drag (which in certain regions and under certain conditions is most economically operated up to a length of 12,000 feet). A launch that has not sufficient power may, if caught in a storm with the drag extended so that it must be cared for, become a menace to the safety of the lives of the officers and men in the party. The launches used by the fishermen generally have sufficient power but lack proper speed. When it is remembered that to insure a through survey some of the areas that must be covered by the wire drag in southeastern Alaska are considerably exposed, and that at the close of each day's work the wire drag must be taken up and the party must proceed in the power launches to some harbor of refuge for the night, it will be evident that speed is a very important factor because time lost in traveling to and from the fields of operations in a slow launch is time lost from making surveys, and while this seems a small factor a close scrutiny of every detail of efficient operations reveals that the loss accruing during an entire season, considering this phase alone, totals an amount that is worthy of serious consideration.

While it is impossible to reach the ideal in speed and power in procuring rented launches for making these surveys, even if this were attainable, to make them at all useful for making wire-drag surveys, there must be a certain amount of reconstruction on any rented launch. Auxiliary gasoline engines must be installed for operating the reels that carry the wire drag when not in operation. Proper provision must be made for stowing buoys, floats, and sinkers, and in some instances where the party must live on the launches, as in Alaskan waters, housing quarters must be built on the launches. This is an expensive and time-consuming operation in the preparation for a season's work, and at the close of the season the launch must be restored to the owner in its original condition. This cost approximates \$800 per party for each season.

This condition should be remedied by the Government owning the power launches that are necessary to propel the wire drags. Every

other unit of the wire drag has been developed to the highest degree of perfection, and experience has shown exactly what is needed in a suitable wire-drag launch, and the time is now ripe for the construction of launches to meet exact conditions. The resulting economy in accomplishments and overhead charges saved in altering and restoring rented launches must far outweigh their cost.

While the results have been highly practical, the work with the wire drag in the past has been necessarily somewhat experimental, but the point has been reached now where it is definitely known what can be accomplished with the wire-drag survey, how it should be accomplished, and (with the exception of Alaskan waters, where, as I have pointed out earlier in this report, some of the areas lack even reconnaissance surveys) it is known what areas require the wire-drag surveys.

There is another important feature in connection with these power launches, and that is that when the season or conditions do not permit their being used in making wire-drag surveys, they can be employed in carrying on inshore hydrography, a class of work which is waiting to be done in many important localities and for which proper vessels are not always available for hire.

With respect to the extent of the wire-drag work done and to be done, below is a table that is enlightening.

Region.	Wire-drag surveys completed (square statute miles).	Wire-drag surveys to be made (square statute miles), approximated.
Coast of—		
New England.....	1,739	1,800
Florida.....	216	500
Porto Rico.....	14	2,800
Alaska.....	1,638	50,000
Entrance to the Canal Zone.....	200	200
Total.....	3,807	54,800

The above table gives particulars regarding the principal areas where wire-drag surveys have been made and must be made, but there are many smaller localities where examinations must be made and have been made with the wire drag (such as San Francisco Harbor) and extensive water areas where the wire-drag surveys must eventually be made (such as the coral-reef-infested waters of the Philippines, Hawaii, and Guam) but for which the facilities in personnel and equipment are not now available, and therefore they are not here considered.

NOTE.—In the sundry civil bill for 1919 there is an item of appropriation of funds sufficient to construct four wire-drag launches. Every possible step is being taken to have these constructed at the earliest practicable moment, and when they are put into the field it is certain that the results will demonstrate the economy of providing a highly efficient instrument for the accomplishment of a special class of work.

ENLISTMENT OF SEAMEN.

Mention has been made of the fact that the three vessels available for surveys in Alaskan waters were necessarily forced to lie idle in Seattle during most of the fiscal year, the *Explorer* and *Taku* being in the field but a month each and the *Patterson* less than three months, and that this was necessarily so because of the lack of officers and the difficulty of enlisting seamen to man the vessels.

The causes that lead to this state of affairs are many, and while the results have not been so manifest during normal times, yet, even then matters were not going in the harmonious way that was desirable, but during the stress of war, where conditions are abnormal, and an important arm of the Government service is crippled, the need of some remedial measures is keenly felt.

An inquiry into the causes of these conditions leads to a diversity of considerations.

I have already made mention of the fact that employment on a vessel of the Coast and Geodetic Survey is considered with little favor by seamen. Employment may be continuous on a merchant-marine vessel, while it is but for the surveying season on a Coast and Geodetic Survey vessel on the Pacific coast with the certainty that at the close of the surveying season his employment terminates for months. Further, that the duties required of a seaman on a merchant vessel are less exacting than on a Coast and Geodetic vessel, and that a seaman on a merchant-marine vessel receives overtime pay for overtime work which is impracticable on a Government vessel.

While the foregoing are, in a measure, results, the cause of these conditions may be summed up as follows:

The vessels of the Coast and Geodetic Survey that have been employed on Alaskan surveys are old. The quarters on these vessels for the crews are of the type found in such old vessels and uninviting. They are devoid of modern equipment, and the ordinary comforts are not possible. For this reason they are shunned by the better class of seamen who can command employment on modern vessels.

As a consequence of their age and unseaworthiness, these vessels can not be employed in open and exposed waters. Therefore, during the winter season they must tie up and undergo repairs. The result is that the crews must be discharged during the winter months and new crews enlisted at the beginning of the succeeding summer season. This enlistment is no more than a civil contract, and since a seaman is not usually possessed of means there is no way of effectually binding him. Hence, with the fluctuating wages that were being paid when the *Patterson* and *Explorer* reached the field of operations in Alaskan waters in 1917 and the seamen found that the wages ashore or on the cannery vessels were much in excess of what they were receiving, though they had signed a contract of enlistment in Seattle at what was conceded to be a fair wage for the season, they deserted the surveying vessels for employment elsewhere, and there were not funds available for the Coast and Geodetic Survey to meet this competition. Due to the fact that there was no Alaskan port where new crews could be recruited, there was nothing for the officers of the vessels to do but to close the surveying season and

return the vessels to Seattle as best they could. The matter has been given serious consideration, but it is doubted if a civil contract can be drawn that will effectually hold seamen who enlist under such a contract on a vessel at Seattle and immediately desert when the to Ketchikan, the wages lost by the seaman are insignificant in comparison to prevent seamen enlisting only for the purpose of getting to another port, as the only penalty that can be inflicted is a forfeiture of wages earned, and since it is only four days' run from Seattle to Ketchikan, the wages lost by the seaman are insignificant in comparison with the cost of transportation, and if they desert in numbers as in the cases cited, nothing remains to be done but to suspend operations and bring the vessels to their home ports, because the demands, industrial and otherwise, that have enticed the seamen from the surveying vessels have already called forth every available man in the locality, and there is no possibility of recruiting new crews.

It is believed that there is a permanent solution of this difficulty that is bound to result in highly increased efficiency and ultimately in great economy, though it involves an increased initial expenditure of Government funds and a somewhat radical departure from present methods.

It is perfectly evident that the highest degree of efficiency can never be attained in a service where the duties that its seamen are called upon to perform are sufficiently different from those performed by ordinary merchant seamen to require special training and instruction covering months before the seamen become proficient, when such seamen are only employed for the surveying season of some six or seven months, discharged, and an entirely new crew recruited when the vessel goes to the field the succeeding season.

Attention has been called to the need for additional surveys of the waters contiguous to Washington, Oregon, and California.

The remedy suggested is this:

1. That surveying vessels be provided of a type sufficiently staunch to make surveys in Alaskan waters during the summer months and in the exposed waters of Washington, Oregon, and California during the winter months.

2. That the appropriations for manning the vessels of the Coast and Geodetic Survey be increased so that a standard wage can be paid the seamen on the vessels of this service throughout the year.

3. That authority be granted to enlist seamen for service in the Coast and Geodetic Survey for a period of one year that will be binding upon them during the period of the enlistment as are enlistments in the Navy.

From such an arrangement benefits are bound to accrue to both the seamen and the Government. Employment for seamen will be continuous under conditions that are agreeable, the Government will have trained complements of men on its vessels familiar with the more or less intricate details of making surveys, and will be able to draw to the service competent and suitable seamen who will have before them prospects of continuous service and advancement in pay where good conduct merits it, and, what is most important, surveys that are of vital importance to the protection of life and property will be accelerated far in excess of possible accomplishment under present conditions.

RETIREMENT FOR COMMISSIONED OFFICERS.

From year to year in the annual reports of the Coast and Geodetic Survey mention has been made of the need of some system of retirement in order to bring about the maximum of results with the greatest economy. The Coast and Geodetic Survey is the oldest scientific Bureau of the Federal Government, and naturally the evils attendant on superannuation are quite apparent. In the hearings before the Appropriation Committee of the House of Representatives, in February, 1917, in summing up the situation regarding the Coast and Geodetic Survey the Superintendent said:

We have to-day this condition: We have in the neighborhood of 20 men, employees of the Coast Survey, who are between 66 and 82 years old. A great many of those men were in authority two years ago. They were not able physically to carry the big load which was evidently necessary, if the real work was to be done. I have changed this the best I could by reducing them to positions where the salaries are more commensurate with the duties which they can and are performing and which their physical condition will permit; but you can see again that it would be better to have half as many younger men, for then we would get more work done. But, I ask, what is going to be done with them? They have served the Government faithfully; some of them had gone into the Government at 18 or 20 years of age, and they have worked for the Government throughout their lives. Their education is similar to the education of an Annapolis or West Point graduate, as far as civil engineering is concerned. They have paid their own tuition; they have stayed with the Survey all their lives at modest salaries; and now in their declining years they practically have no money. The Survey is really loaded with a portion of the force that is not returning the value it should, though not through its fault. I only speak of this to show another factor in the condition that has existed as an obstacle in the sense that we are handicapped in accomplishing everything we should with the positions that exist as shown, in fact, in the Book of Estimates.

I have often thought that it would be well for the Survey if the committee could spend a short time in our office and see what has been accomplished and how conditions have changed through a century, and how an old Bureau suffers from superannuation, tradition, and, I might say, dry rot. They would see why something modern, something new, creates a natural interest among the public, and will therefore command a greater amount of interest and respect; and that is what we have right there.

In justice to these officers whose efforts and highest ambitions throughout their associations with the Coast and Geodetic Survey have been along the lines of scientific work peculiarly requisite to the purpose of the Coast and Geodetic Survey, but which have not provided a competence for old age, legislation providing for their retirement should be enacted.

The commissioned officers in the Coast and Geodetic Survey now number 124. Of these 10 are more than 64 years of age, and have had an average service of over 44 years in the Coast and Geodetic Survey. Sixteen are more than 60 years old, and have had an average service of 42 years in this Bureau. To retire those above 64 years of age on three-fourths pay would have required but an appropriation of \$16,650 for the current year, and would have opened the way to bring into the service 10 new field officers whose services are sorely needed.

The fact that the pay these officers have received during the years that they have been identified with the Coast and Geodetic Survey has been too small to permit laying aside a competence for old age is not, however, the principal consideration in urging retirement for

them. The stronger reason is the privations endured and the risks incident to the service. The surveys that are made by the Coast and Geodetic Survey ought to, and generally do, precede commerce, and not infrequently civilization. The small surveying vessels of the Coast and Geodetic Survey must enter, explore, and survey unknown waters in advance of commerce, in advance of the vessels of the Navy, the Coast Guard, and all other vessels. The hydrographic parties of the Bureau must go into unexplored waters and make examinations that the commerce that follows may be safe. In the execution of this work these parties are cut off from communication and intercourse with civilization for weeks and even months at a time, and often in the Philippines are necessarily thrown in direct contact with the uncivilized natives of the tropical forests bordering the waters where these hydrographic surveys are made. Indeed, it is not infrequent that our officers by force of arms must overcome the resistance of these uncivilized tribes to the landing of shore parties for the purpose of erecting signals as a basis for the control of the hydrographic surveys. And, again, it is no safe task, in the tropical jungles of the Philippine Islands, with but a few facilities at hand, to build a triangulation signal station 235 feet high out of native timbers that must be cut from the trees on the spot.

At this writing, one of our young officers of the age when he should be in the prime of life, and who when he came into the service was of strong physique, is in a sanitarium, stricken with disease which can be attributed to no other cause than the exposure to which he was subjected in the field work of this Bureau in the Philippines.

The surveying work of this Bureau extends over a wide field. Besides being exposed to the tropical diseases and dangers of the Philippines, its officers have been sent into the desolate Arctic regions in determination of the one hundred and forty-first meridian, the boundary line between Alaska and Canada, and for self-preservation have been forced to assume civil charge of the native Indian population and exercise strict authority to stamp out epidemics of smallpox.

In carrying out the work of primary triangulation of any country, triangulation stations to be intervisible must be on the highest promontories, and in mountainous or heavily timbered country much daring is required and considerable risk incurred in the construction of suitable signals. One of the men engaged on the preparation of the triangulation station shown in figure 15^a lost his life.

In making hydrographic surveys of Alaskan waters, the officers of the Coast and Geodetic Survey have been particularly exposed to dangers. The small surveying vessel is no match for the gales that are common to that country, and it is only through foresight in selecting harbors of refuge and good seamanship that disasters have been averted.

While it is not the regular function of the Bureau, its officers play no small part in saving lives and property. Almost monthly word comes to this office of assistance lent vessels in distress or lives and property saved. The *Tahoma* of the Revenue-Cutter Service struck an uncharted rock in the North Pacific Ocean, resulting in her total loss, and a part of her crew was only saved by the com-

* Not included in this compilation.

manding officer of the Coast and Geodetic Survey steamer *Patterson* instantly responding to her call of distress and steaming 700 miles to the scene of the accident. Persons have been rescued from stranded ships in all our waters by officers of the Coast and Geodetic Survey.

These are the risks and hardships incident to the civil employment of the officers of the Coast and Geodetic Survey. In military activities, whenever the need has arisen, they have taken their part. Pages have been written of their participation in the Civil War in which 55 took an active part in the Army and 48 in the Navy, and while their services are shown to have been highly prized by the testimonials of the military and naval officers under whom they served, they were in the Army and Navy without any status, and, if captured, would not have been accorded the protection of prisoners of war but would have been subject to execution as spies. Permanent legislation has been enacted authorizing the President to transfer by Executive order to the Army and Navy the officers of the Coast and Geodetic Survey as necessity demands, in effect making the service a military reserve force. In the exercise of this authority 25 commissioned officers have been transferred to the Army and 42 to the Navy.

The commissioned officers of the Coast and Geodetic Survey to be of normal efficiency must be a permanent force. That is to say, the work of the Bureau is so specialized in particular branches of the field of engineering that the young men that come to the service from universities where they are highly trained in the science of engineering must have a long course of special training by the officers of the Coast and Geodetic Survey before they become proficient and render valuable service in carrying on the specialized work of the Bureau. Owing, therefore, to this special knowledge and training required, the field engineers of the Bureau must be a permanent staff, and it is only after years of experience and training that they become of the greatest value. It therefore follows that shortly after becoming identified with the Bureau the young engineer must take thought of these things and determine that he will cast his lot with the Coast and Geodetic Survey during his professional career, or, he must early seek other field of service because his engineering work with the Bureau is highly specialized, and long training in its parties rather tends to make the engineer less than more fit for successful competition in the broader field of engineering. It therefore follows that those who have been in the service more than a very few years will, and are devoting their lives to the advancement of this public service.

These, then, are the reasons that justify a claim for retirement for the commissioned officers of the Coast and Geodetic Survey.

It must certainly promote efficiency in the field force of the Bureau to retire at three-quarters pay those officers who have passed 64 years of age, and bring into the service young, vigorous officers who can endure the physical hardships incident to the service.

In justice to the officers who have risked their lives for years in the hazardous civil branch of the Government service, and who have taken and are taking an active part in the military services at times when the risks incident to such service are greatest, the benefits of retirement which are accorded those permanently in the military serv-

ices should be extended to those who go into it while the chances of sacrifice are greatest—namely, in time of war.

The following is a concrete and illuminating statement of the record of one of our commissioned officers (hydrographic and geodetic engineers) who has had 47 years of service with the Coast and Geodetic Survey.

He was born in 1848. After leaving Dartmouth with a science degree he entered the service of the Coast and Geodetic Survey in 1871 with pay at \$30 a month and actual living expenses, a continuous service of 47 years. This officer has served the Coast and Geodetic Survey in nearly every State in the Union on practically every class of surveys made by the Bureau at various rates of pay, and his average pay throughout his identification with the Bureau has been \$1,815 per annum. He has been in charge of parties on triangulation observations, on astronomic observations, on topography, in command of vessels of the Bureau on the Atlantic coast, on the Pacific coast, in Alaskan waters on the original survey of the Yukon delta and approaches, in Philippine waters, where he was in command of the largest vessel of the Bureau for some years; he has made surveys in the arctic regions of Alaska in the determination of the boundary line between Alaska and British Columbia, exploratory surveys in Alaska for the purpose of opening up the country at the time of the rush to the Alaskan gold fields; and he has been the principal surveyor for a commission to determine the site for a navy yard on the Pacific coast. In office work he has been chief of a division in the Washington office of the Coast and Geodetic Survey, and in charge of one of the most important stations of the Coast and Geodetic Survey on the Pacific coast, a position of responsibility and requiring a thorough knowledge of all the activities of the Coast and Geodetic Survey.

The above is a typical example of a number of others that could be cited, where an officer has unselfishly devoted the best years—in fact, all of the producing years—of his life to the advancement of a scientific bureau under conditions of living that have taken him to practically every State in the Union and all the possessions of the United States, have never permitted the establishment of a permanent place of residence or a home, and have necessitated an increased living expenditure which an average salary of \$1,815 per annum has barely met.

NEED OF 28 ADDITIONAL HYDROGRAPHIC AND GEODETIC ENGINEERS.

In recognition of the greatest need, 67 commissioned officers of the Coast and Geodetic Survey have been relieved temporarily from their duties in the Coast and Geodetic Survey and have gone into active service in the War Department and the Navy Department. This is necessarily curtailing the field accomplishments of the Coast and Geodetic Survey, but the training and experience of these officers are such that they are of much value to the military branches of the Government, and during the national crisis it is far better to utilize the services of such number of them as can temporarily be spared in the Army and Navy than in civil employment with the Coast and Geodetic Survey.

While the regular work of the Coast and Geodetic Survey is thus curtailed and the energies of those remaining in civil employment

with the Bureau are directed toward accomplishments necessary to the Navy and requested by the Army, it is still proper to consider the needs of the Bureau in the way of field officers to adequately perform the duties that are properly assigned to the Coast and Geodetic Survey. In the report of the Bureau for 1916 it was urged that 48 additional commissioned officers were needed to properly carry on the field work of the Bureau. In partial recognition of this need, 20 new positions have been granted. While this added personnel has been of great assistance in putting new life into a public service that was languishing, we are yet short 28 officers to put it on a footing so that the commissioned personnel will be sufficient in number to properly take care of the field work.

Attention has been invited to the fact that for the purpose of properly safeguarding our new merchant marine closer surveys must necessarily be made of our navigable coastal waters, and this will require an increased commissioned personnel.

For years past this Bureau has earnestly urged a closer network of accurately determined control points throughout the United States as the basis for maps of the country. The present military necessity has served to emphasize this need as has nothing in the past, and the accurately determined positions already fixed by this Bureau, insufficient in number as they are, are serving as a nucleus for preparing maps of the highest degree of accuracy for the Army. The work of accurately determining these positions ought to be taken up vigorously. The results are not ephemeral as some of the results of other surveys must from their very nature be, but a position once accurately determined and permanently marked will ever after serve as a basic control for maps and engineering projects. To push this framework of control points, additional field officers are necessary.

Part II.—WORK AND NEEDS OF THE WASHINGTON OFFICE.

CHAPTER I.

WORK OF THE WASHINGTON OFFICE.

The organization of the Washington office throughout the year, by divisions and sections, was as follows:

Division of hydrographic and geodetic engineer in charge of the office: Section of instruments, section of printing and sales, section of library and archives, and section of miscellaneous.

Division of geodesy.

Division of hydrography and topography: Section of field work, section of field records, section of field equipment, section of coast pilot, and section of tides and currents.

Division of charts: Section of drafting, section of engraving, and section of photography.

Division of terrestrial magnetism.

Division of accounts.

The work done by the Washington office during the fiscal year, by divisions of the office, was as follows:

Division of hydrographic and geodetic engineer in charge of the office: The general duties of this division are: The upkeep of the buildings occupied by the Bureau; the designing and repairing of surveying instruments and equipment, and packing and shipping them to the field parties; the printing of the charts issued by the Bureau, and the sale of the charts, coast pilots, and tide tables; the purchase of supplies for the office, for the chart printing work, and for the field; the care and custody of the original records of field surveys as well as the library of printed publications kept for the use of the Bureau; the keeping of the records of leave taken by the personnel of the Bureau; and the custody and accounting for the receipts from the sale of charts and publications sold by the Bureau.

In addition to the general routine, special improvements were made by this division as follows:

Much apprehension has been felt in the past in view of the known danger of fire that would destroy records that are the results of surveys covering more than 100 years stored in the archives of the Survey. This apprehension is now removed. During the fiscal year an automatic sprinkler and fire-alarm system especially provided for by Congress was installed throughout the buildings occupied by the Bureau, but with special protection for the part of the buildings in which are stored the original records and field sheets which are the results of field surveys.

The most valuable improvement and progress toward the establishment of efficiency in the office was secured through the installation of an additional modern offset press in the printing plant. The Bureau is now supplied with a modern offset press and

a flat-bed press, and this has provided the means for a much more rapid production of charts of a better quality than it has been previously possible to produce. Without this additional modern press the extraordinary demands for navigational charts by the Army, Navy, and merchant marine under the existing war conditions could not have been met with efficient promptness.

In September, 1917, an automatic elevator controlled by push buttons was installed in the printing building, and a runway constructed connecting the second story of the new printing building with the paper room in the old printing building and Butler buildings. These two improvements have greatly facilitated the work. In November a new 57-inch Oswego paper-cutting machine was installed in the pressroom of the printing office, and in January, 1918, an offset proving press, motor-driven, was installed in the transfer room of the printing office.

The issues of charts for the fiscal year was slightly less than for the previous year, but the issue of coast pilots increased remarkably.

During the year 1,115 instruments, apparatus, tools, etc., were repaired in the instrument shops; 948 instruments, apparatus, tools, etc., were made; and 2,610 instruments were purchased.

Instruments issued to the field during the year.....	2,816
Instruments received from the field during the year.....	3,301
Articles of general property issued to the field during the year.....	7,788
Articles of general property received from the field during the year.....	4,608

Much special investigation that was contemplated looking to the improvement of instruments and the designing of new instruments has necessarily been suspended due to the fact that so much time in the instrument section has been devoted to war work.

The fact that the country is on a war basis has necessitated the purchase of additional supplies to produce the increased output of the Bureau, and this has placed greater burdens on the purchasing section of the office. The expenditures from appropriations for the office for 1917 were \$89,985, while for 1918 they were \$120,127.

Effort has been made to reduce the volumes in the reference library to actual necessity, and in carrying out this purpose a list of those publications deemed of no further use to the Bureau has been sent to the various departments and selections have been made by a number of the bureaus of the departments, thus reducing those on hand in the library of this Bureau to what are actually needed.

Sixty-one hydrographic, 44 topographic sheets, and 3,552 field, office, and observatory records were received during the year and filed in the archives.

The total number of permanent and temporary employees in the field and office, excluding hands, etc., not appointed through civil-service certification, was:

Office force.....	210
Field force.....	135
Total	345

The average number of days of annual and sick leave taken by the combined field and office force was 19 and the average number of days of sick leave taken by the combined field and office force was less than 4½. The overtime service performed by the employees of the office during the fiscal year amounted to 1,438 days, or approximately 7 days for each employee.

The receipts from the sale of charts, publications, old property, etc., amounted to \$21,622.96.

DIVISION OF GEODESY.

The most important pieces of work which were completed during the past fiscal year or which were in progress during that time are the following:

Computation and adjustment of the following pieces of triangulation:

1. In Maryland.
2. In Rhode Island.
3. In Massachusetts.
4. Utah-Washington arc of primary triangulation.
5. Pasquotank River, N. C.
6. Ninety-eighth meridian south, connecting with the ninety-eighth meridian triangulation.
7. Laguna Madre, Tex.
8. Tampa Bay, Fla.
9. Rio Grande arc of primary triangulation.
10. Atlanta-Griffin, Ga., primary triangulation.

The computation of the following lines of primary traverse:

1. Brunswick-Columbus, Ga.
2. Jacksonville, Fla.-Columbus, Ga.
3. Macon-Griffin, Ga.
4. Albany, Ga.-Callahan, Fla.
5. Savannah-Everett, Ga.
6. Macon-Savannah, Ga.
7. Norfolk, Va.-Savannah, Ga.

The computation and adjustment of the following lines of precise levels:

1. Little Rock, Ark.-Memphis, Tenn.
2. Marquette-Escanaba, Mich.
3. Algonac-St. Clair Flats, Mich.
4. Brunswick-Macon, Ga.
5. Macon-Columbus, Ga.
6. Jacksonville, Fla.-Columbus, Ga.
7. Macon-McDonough, Ga.
8. Albany, Ga.-Callahan, Fla.
9. Sierra Blanca-San Antonio, Tex.
10. San Antonio-Laredo, Tex.
11. New Braunfels-Brownsville, Tex.
12. Macon-Savannah, Ga.
13. Savannah, Ga.-Ulee, Fla.
14. Sinton, Tex.-New Orleans, La.

The computation of azimuth along the primary traverse lines in Georgia and Florida, and along the Rio Grande arc of primary triangulation, the observations for which were made in 1917-18.

The computations of latitude and longitude along the primary traverse lines in Georgia and Florida.

The computation of tables for constructing a 1:10,000,000 base map for the United States on the Lambert zenithal equal area projection.

During the year, the computation of 3,517 kilometers of precise leveling was completed at an average cost of 21 cents per kilometer. The introduction of new methods in the computations, the elimination of minor corrections whose effect upon the final elevations of the bench marks proved to be negligible, and the introduction of the adding machine as a recording device in the field work has reduced the cost of computing until now it has reached a figure 40 per cent lower than the average cost from 1909 to 1916, and 6 per cent lower than the average cost previous to 1909.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY.

The office work of this division has been the supervision of the hydrographic and topographic work on the coasts of the United States and insular possessions; the vessels of the Survey, including their construction, maintenance, repair, equipment, personnel, and office records; the field stations, including the office of the Director of Coast Surveys, at Manila; the completion in the office of the field records of the surveys; the compilation of the coast pilot in the field and office; and the tide and current work of the Survey, including the compilation of the tide tables.

Orders and instructions for the personnel and parties engaged in the above-named work, and the necessary correspondence, have been prepared in the division of hydrography and topography. The division includes five sections, namely: Field work, field records, vessels and equipment, coast pilot, and tides and currents.

During the year there were data collected and itemized memoranda prepared for 20 sets of instructions for field work. This embraces a careful study of the existing surveys, the nature of the bottom, the reviewing of reports upon previous work, and the required closeness of the work needed to obtain a comprehensive survey of the locality in question.

Original field sheets covering areas where changes frequently occur and where preliminary surveys only have been made were reviewed, in order to formulate plans for performing the field work necessary to bring the charts up to date.

As time permitted, completed field sheets were reviewed in the section preparatory to recommending them for the Superintendent's approval. There were 90 hydrographic sheets closely inspected, and memoranda bearing on the work were prepared for insertion in the descriptive report accompanying each sheet.

During the year the coast pilot section carried on field work on the North Atlantic coast, and as a result of the field work two coast pilots, Atlantic Coast Pilot, Section A, from Eastport, Me., to Cape Cod, and Atlantic Coast Pilot, Section B, from Cape Cod to Sandy Hook, were compiled. Numerous chart corrections collected during the course of the field work were submitted. The above volumes complete the issue of all coast pilots on the Atlantic and Pacific coasts of the United States and of Alaska in the new octavo form.

Reprints were obtained during the year of Atlantic Coast Pilots, parts 1, 2, 3, and 4, Sections C and D. Supplements for five volumes and such correction sheets as were necessary to keep the information in all volumes up to date were issued.

The Tide Tables for 1918 were received from the printer in September, 1917. These tables are similar to those of the preceding year, but full predictions are given for four additional ports, namely Savannah, Ga.; Anchorage, Cook Inlet, Alaska; Cebu, P. I.; and Port Hedland, Australia. The standard port of Amboy, China, has been discontinued, leaving 81 stations for which full predictions are given. Some other minor changes were made to make the volume more useful to navigators.

The manuscript of the Tide Tables for 1919 was prepared and submitted for printing in three separate parts as follows:

The manuscript of the Atlantic Coast Tide Tables was prepared and submitted in advance, before the other portions of the General Tide Tables had been predicted; then the Pacific Coast Tide Tables were prepared and submitted for printing; and last of all what remained of the General Tide Tables was prepared and submitted. This arrangement is convenient to carry out, and under peace conditions will greatly expedite the early receipt of the volumes for issue.

The Italian Government requested this Survey to furnish predicted tides for Venice, Italy, for the two years, 1918 and 1919, which was done. The government of Western Australia was furnished with copies of the proof sheets of the predicted tides for Port Hedland, Australia, for the two years, 1918 and 1919.

The computations for the graduation of the scales of the new form of sounding tube was completed in this section, and also the corrections to be applied for variations in the height of the barometer and for changes in the temperature of air and water.

DIVISION OF CHARTS.

The following statistics show the accomplishments of this division in the way of drafting, engraving, and photographic work for the past year, as well as the accomplishments for 1914, 1915, 1916, and 1917:

Work done.	1914	1915	1916	1917	1918
DRAFTING.					
Schemes approved for new charts.....	20	18	4	8	11
Approved schemes on hand, charts not started.....	4	11	6	5	8
Drawings for new charts finished.....	18	18	4	11	15
Drawings for new charts finished in hand.....	16	8	10	10	10
New drawings for new editions finished.....	7	4	10	11	7
New drawings for new editions in hand.....	6	6	10	4	3
Extensive corrections finished.....	57	137	157	151	95
Extensive corrections finished in hand.....	9	18	11	14	10
Chart drawings from Manila for new charts finished.....	8	3	2	3	1
Chart drawings from Manila for new charts in hand.....	1	1	1	1	1
Chart drawings from Manila for new editions finished.....	10	4	5	14	4
ENGRAVING.					
New plates for new charts finished.....	6	3	2	8	6
New plates for new charts in hand.....	7	12	11	6	9
New plates for lithographic charts finished.....	1	1	1	3	1
New plates for lithographic charts in hand.....	1	1	3	2	8
New bases for new editions finished.....	18	19	11	16	7
New bases for new editions in hand.....	13	16	16	3	2

Work done.	1914	1915	1916	1917	1913
ENGRAVING—continued.					
New bases for releases finished.....	16	16	3	9	17
New bases for releases in hand.....	15	6	10	18	10
New editions using current plates finished.....	14	18	24	32	16
New editions using current plates in hand.....	6	4	2	2	14
Extensive corrections applied to plates.....	239	286	314	269	144
Extensive corrections applied to plates in hand.....	9	11	14	7	17
Miscellaneous plates engraved or corrected.....	11	11	22	21	1
Minor corrections applied to plates.....	1,198	1,145	1,153	696	719
Charts in section, engraving not started.....					
PHOTOGRAPHING.					
Glass negatives made.....	1,184	1,189	1,225	1,109	1,208
Paper negatives made.....	30	9	11		6
Velox prints made.....	1,903	1,968	4,313	3,413	1,781
Vandyke prints made.....	241	64	52	36	8
Bromide prints made.....	317	259	500	391	499
Blue prints made.....	1,837	3,127	2,411	1,921	1,513
Photostat prints made.....	11,381	15,224	18,549	11,017	11,550
Lantern slides made.....	11	172	354	206	109
Matrices made.....	101	90	43	96	52
Redeveloped prints made.....				197	267
Prints mounted.....	19	18	39	63	118
Negatives developed.....			22	41	22
Photolithographic negatives, number of charts.....	52	49	30	29	110

DIVISION OF TERRESTRIAL MAGNETISM.

The results of the field work executed during 1917 were computed and prepared for publication.

The reduction of the work of the five magnetic observatories for 1916 was completed, and the results for 1915-16 were prepared for publication. The reduction of the observatory work for 1917 was well advanced for each of the observatories.

The earthquakes recorded at the five magnetic observatories have been tabulated monthly, and the results have been published in the Monthly Weather Review and transmitted to the International Seismological Association and others engaged in a comparative study of earthquake data.

An isogonic chart of New England for 1918 was prepared for the use of the Geological Survey.

A table giving the value of the magnetic declination at numerous places in the United States for 1918 was prepared for insertion in the World Almanac. Revised tables pertaining to terrestrial magnetism were prepared for a new edition of the Smithsonian Physical Tables.

Some progress was made in the reduction of the work of the San Antonio Observatory, 1890-1895. The card catalogue of the field results was very nearly completed.

Proof has been read of the following publications which have been sent to the printer during the year:

MAGNETIC TABLES AND MAGNETIC CHARTS FOR 1915.

Results of Magnetic Observations Made by the Coast and Geodetic Survey in 1917.

Results of Observations Made at the Tucson Magnetic Observatory in 1915 and 1916.

Results of Observations Made at the Honolulu Magnetic Observatory in 1915 and 1916.

Results of Observations Made at the Sitka Magnetic Observatory in 1915 and 1916.

Results of Observations Made at the Porto Rico Magnetic Observatory in 1915 and 1916.

Results of Observations Made at the Cheltenham Magnetic Observatory in 1915 and 1916.

Compass data were supplied for 200 charts.

PUBLICATIONS ISSUED DURING THE YEAR.

ANNUAL REPORT.

Annual report of the Superintendent, United States Coast and Geodetic Survey, 1917.

TIDE TABLES.

General Tide Tables for 1918.

Atlantic Coast Tide Tables for Eastern North America, 1918.

Pacific Coast Tide Tables for Western North America, Eastern Asia, and Many Island Groups, 1918.

COAST PILOTS.

United States Coast Pilot, Alaska, Part I.

Dixon Entrance to Yakutat Bay, sixth edition, 1917.

United States Coast Pilot, Pacific Coast, California, Oregon, and Washington, third edition, 1917.

SUPPLEMENTS TO COAST PILOTS.

Supplements to third edition, United States Coast Pilot, Atlantic Coast, Part III; Cape Ann to Point Judith, August 10, 1917. April 19, 1918.

Supplement to United States Coast Pilot, Atlantic Coast, section D. November 23, 1917.

Supplement to United States Coast Pilot, Atlantic Coast, Parts I-II. St. Croix River to Cape Ann, November 23, 1917.

SPECIAL PUBLICATIONS.

No. 42. Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1916. By Daniel L. Hazard.

No. 43. Triangulation in Georgia. By C. H. Swick.

No. 44. Magnetic Tables and Magnetic Charts, 1915. By Daniel L. Hazard.

No. 45. Descriptions of Triangulation Stations in Georgia. By C. H. Swick.

No. 46. Lambert's Conformal Conic Projection. By C. H. Deetz.

No. 48. The Neglected Waters of the Pacific Coast, Washington, Oregon, and California. By E. Lester Jones, Superintendent.

No. 49. Lambert Projection Tables, with Conversion Tables. By C. H. Deetz.

No. 50. Safeguard the Gateways of Alaska: Her Waterways. By E. Lester Jones, Superintendent.

No. 51. Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1917. By Daniel L. Hazard.

No. 52. Lambert Projection Tables for the United States. By Oscar S. Adams.

No. 53. General Theory of the Lambert Conformal Conic Projection. By Oscar S. Adams.

SEPARATE PUBLICATIONS.

Catalogue of Charts, Coast Pilots, and Tide Tables, 1918.

Supplement to Catalogue of Charts. February 14, 1918.

Rules and Regulations for the Government of the Washington Office of the United States Coast and Geodetic Survey, effective October 1, 1917.

Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Ariz., 1915-16. By Daniel L. Hazard.

Supplement to the Regulations and Instructions for the Government of the United States Coast and Geodetic Survey, from January 1 to June 30, 1917.

Supplement to the Regulations and Instructions for the Government of the United States Coast and Geodetic Survey, from July 1 to December 31, 1917.

Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Sitka, Alaska, 1915-16. By Daniel L. Hazard.

Results of Observations Made at the United States Coast and Geodetic Survey Magnetic Observatory near Honolulu, Hawaii, 1915-16. By Daniel L. Hazard.

Results of Observations Made at the United States Coast and Geodetic Survey Magnetic Observatory at Vieques, P. R., 1915-16. By Daniel L. Hazard.

BULLETINS.

Coast Survey Bulletins, issued monthly, from July, 1917, to June, 1918, inclusive.

97796°—COM 1918—43

CHAPTER II.

NEEDS OF THE WASHINGTON OFFICE.

The weakest units in the series of operations through which information is gathered from original surveys and issued to the public in the form of printed charts, coast pilots, tide tables, etc., is the lack of a sufficient number in certain classes of personnel in the Washington office of the Coast and Geodetic Survey. This lack of personnel has caused the flow of this information to become stagnant so that there are accumulations of data in the office from original field surveys that can not be passed on to the public in the printed output of the Bureau before some of it becomes antiquated, and even superseded in some changeable areas by later surveys because the personnel of the Bureau that handles phases of this output is not sufficient in number to cope with it. Stated in the order of the Bureau's present requirements, the classes of personnel where relief is urgently needed are as follows: (1) Draftsmen, (2) computers, and (3) clerks.

DRAFTSMEN.

The term "draftsmen" as applied to the employees of the Coast and Geodetic Survey who compile the charts is a misnomer. The mechanical drawing of the characteristics shown on the published chart is by far the least exacting of any duties of the force engaged on this work. The more serious problem is the examination of the mass of data from all sources, some of which are unquestionably accurate, other of doubtful reliability, and still others that may or may not be accurate, and out of these draft a chart that truly represents conditions. To be more explicit, the following are a few things that confront our men engaged on this work. Say a new edition of a chart of an important waterway is being drawn. The man compiling the information for this new edition of a chart has before him the old edition of the chart, the original field sheet of the surveys of the locality made 60 years ago, an original field sheet of an examination made in search of a reported danger in the locality made 5 years ago, an original field sheet of a resurvey made 20 years ago, some hundreds of blue prints of examinations made by the Corps of Engineers in different localities at different times for years past over the area covered by the chart, maps, and blue prints made by State authorities, by municipal authorities, and by county authorities of various areas covered by the chart, numerous reports made by the Bureau of Lighthouses regarding the changes in locations of aids to navigation, and reports by the Coast Guard of the location of wrecks and dangers to navigation.

From this mass of material and information must be determined the data that shall go on a new edition of a chart. These surveys made by different agencies and at different times may not be consistent one with the other in positions given for dangers located.

depths, or aids to navigation, or they may overlap and show inconsistent depths. In compiling this information for the purpose of printing a chart due regard must be given the object in view when the survey was made, for it is obvious that if soundings are made by the Corps of Engineers to determine the depths obtained in dredging a channel, then incidental scattered soundings made of adjacent waters, overlapping and inconsistent with closer surveys made at other times, may or may not be accurate as to conditions where these scattered soundings are made, yet these made in the channel are the last word as to accuracy as to the depths of the channel. Therefore, to take this mass of miscellaneous information and prepare an accurate chart requires far more than mere ability to draft, and the man engaged on such work in the Coast and Geodetic Survey is more than a draftsman in the sense in which the word is commonly used. And, even in the mere matter of drafting, the new appointee of the Bureau, fresh from school, is deficient in that the lettering and symbols which are later to be reproduced by photolithography from original drawings on vellum must be of the highest degree of accuracy and neatness, to be issued in the form of a finished product as a chart, and this is far beyond the capabilities of those who come to the Bureau fresh from school.

While the need of the military services has drawn from this Bureau some of its best and most experienced draftsmen, and while others are on temporary leave of absence undertaking work in connection with the war at the direct request of the President, this has only emphasized a condition that has existed for years, namely, that there is and has been a great mass of information in the form of results of original surveys by this Bureau, surveys by the Corps of Engineers, information from the Bureau of Lighthouses, and from other sources that has not and can not be applied to the charts of the Bureau at the time the information is current, because there is not the necessary force of cartographers to digest the information and apply it as fast as it comes to the office.

Because of the high attainments required of those engaged on this work, the salaries should be higher than at present, especially in the lower grades. Indeed, if the positions are to be filled and conditions continue as at present these salaries must be increased because candidates can not be found to fill them. Some of the lower-paid positions have been vacant for months.

COMPUTERS.

The services of computers are required and used in three divisions of this office:

1. In the division of geodesy in the computation of the results of geodetic surveys.
2. In the division of hydrography in making computations for the annual tide tables and discussion of current data.
3. In the division of terrestrial magnetism in the computations of the field and observatory observations and the discussion of the results therefrom.

While conditions are not as bad in these divisions and the masses of data from field observations, etc., are not so great as those before our draftsmen, yet there are many folios of results of field observa-

tions (geodetic, tidal, and magnetic) in our archives containing information that can only be effectively presented for public use in printed form that have not been reached by the computing force, and can not be reached for too long a time.

1. *Nature of work.*—The work done by the computers is technical in character, requiring thorough training, extensive research, continuous study, sound judgment, and expert accuracy, as shown by the character of the publications prepared under their direction. It involves the joining on of new work to old or the fitting together of the work of several seasons, and thus makes the information acquired by years of experience a very important factor in the efficiency of a computer.

2. *Importance of the work.*—It is especially important at this time to prevent any falling off of the quantity or quality of the output of the Survey because of the large amount of work being done for the Army and Navy. About 90 per cent of the time of the computers of the division of geodesy is now devoted to war work, and the demands from the office of the Chief of Engineers are so urgent that that office has authorized the employment of five temporary computers to help out the regular force.

With the present scale of salaries it is not possible to secure new computers of the required training and ability nor to hold the old computers whose value has been enhanced by experience in the work. Of the entire force (authorized) of 31 computers, there are only 6 now in the service who were here at the beginning of 1907. In the division of geodesy, to which 22 of the computers were assigned, there are now only 2 who were there in 1907. Twelve places are either vacant or filled by temporary appointees.

Recently four men took the examination and all four men were offered positions. One of these wanted \$2,000, another \$1,700 as an entrance salary, and the other two refused the position.

The circular announcing the examination was sent to all the leading colleges in the country. One college president wrote to the Survey stating that it was impossible to induce the graduates to accept the computer positions, which required such thorough training and paid such small salaries. During the last few years, every one whose name was on the register of eligibles has been offered a position.

It is impossible with the present salaries to secure and retain computers qualified to perform efficiently the work of this Bureau. It is recommended, therefore, that a readjustment of salaries be made so as to make their average pay more nearly conform to present conditions and to that paid for similar service in other branches of the Government.

The scales of salaries of examiners in the Patent Office and of associate physicists and assistant physicists in the Bureau of Standards are not much different from those proposed for the computers. The entrance requirements for the Patent Office are of the same grade as for computer in this Bureau, as evidenced by the fact that a large number of computers have left this Bureau from time to time to go to the Patent Office.

There has recently been a call for computers in the Ordnance Department, the requirements being substantially the same as for computers in the Coast and Geodetic Survey, the salaries ranging from

\$1,400 to \$1,800 a year. For master computer, with additional requirements of at least two years of experience in engineering or similar pursuits, salaries ranging from \$1,800 to \$2,400 a year are offered.

CLERKS.

While the flow of information from the raw material as gathered from field observations to the perfected printed output in the form of charts, tide tables, and geodetic publications is materially retarded through the lack of a sufficient number of draftsmen and computers, as pointed out above, the smooth working of an efficient organization is further handicapped through another shortage in that the Bureau has not a sufficient number and a stable force of clerks. Relatively it is more important that an additional number of draftsmen and computers be supplied than of clerks because the information that passes through the hands of the former goes to the public in the form of a printed product that is equally available to all and therefore has a broader field of service, yet we are far from able to meet as promptly and fully as is desirable the many requests that come to this office for special information for individuals, Government officials, shipping interests, etc., because we have not the proper number of experienced clerical employees to properly collate the data to supply this information.

This Bureau in relation to its clerical force has a few parallels in the Government service. The work of the Bureau is specialized. The clerical force is not large (42 in number). No two clerks in the Bureau have duties that are exactly similar, and the duties of many are highly technical. From this it follows that when a vacancy occurs in the clerical force the new appointee is assigned to duties which are different from any clerical experience he has ever had before, and there is no other clerk in the division to which he is assigned to assist him to acquire a knowledge of his duties. He acquires this information only at the expense of a great loss of time of the chief of the division where he is assigned, who must instruct him in the details of the work. Consequently frequent changes in the clerical force of this Bureau not only hinder the prompt supplying of the individual inquiries of the public but actually retard the technical work of the Bureau.

Owing to the disparity between the lower statutory salaries in this Bureau and those paid in other branches of the Government service, the changes in the clerical personnel of the Bureau are in excess of the average in other branches of the Government service.

The statutory salary of 50 per cent of the clerical force of the Bureau is not in excess of \$1,000 per annum. There are 42 clerks in the Bureau. The statutory salaries of 21 are as follows: Six at \$720 per annum, 10 at \$900 per annum, and 5 at \$1,000 per annum.

The result was that during the fiscal year no less than 27 persons occupied 5 of the statutory places at \$720 per annum and 33 persons occupied the 10 statutory places for clerks at \$900 per annum. The general average has been that these positions have been held by clerks somewhat less than three months, there being many intervals when candidates could not be found willing to accept such salaries.

The bare facts are that while the Government has really paid from its salary rolls a minimum price for clerical help, it has lost a large

amount of time of highly skilled technical employees who have instructed during one year each of these 60 different incumbents of different clerical positions, and the net result has been a financial loss far in excess of proper salaries that would retain a permanent force of experienced clerks.

INSTRUMENT MAKERS.

There is another need in the office personnel that, however, has a direct effect on field accomplishments, and that is an increased number of and higher entrance salary for instrument makers. These must be specially skilled men in the repairing and making of the intricate parts of delicate surveying instruments, such as theodolites, sextants, levels, etc.—men of a much higher class of attainments than are usually found in quantity production instrument shops of even manufacturers of surveying instruments, because such men are generally skilled only in the production in numbers of special parts of a given instrument, while such employees in the Coast and Geodetic Survey must be able to make necessary parts and repairs to any part of any delicate surveying instrument and with the highest degree of precision, because an inaccuracy in the instrument would bring inaccuracies in the results from surveys made with it.

The entrance salary of \$1,200 is insufficient to attract men of the requisite experience to fill these positions. It is indeed insufficient to attract men at the present time. One of these positions was created July 1, 1917. It was only after a solicitation by correspondence and personal inquiry covering nearly six months that an incumbent was found, and another of the \$1,200 positions has been vacant for months. We are unable to induce any one with any degree of mechanical ability to accept an appointment to fill the vacancy.

RETIREMENT FOR EMPLOYEES OTHER THAN COMMISSIONED OFFICERS.

In the chapter of the "Needs of the field service" attention has been called to the need of legislation authorizing the retirement of commissioned officers of the field force 64 or more years old who have devoted the producing years of their lives to the interest of the Coast and Geodetic Survey at rates of pay that have not permitted the accumulation of a competence for old age. Retirement for these old officers has been earned and is merited in view of the hazards and perils through which they have passed and which have been incident to the field service of the Coast and Geodetic Survey.

There is, however, another class of employees in the Coast and Geodetic Survey, in common with many other branches of the Government service, for whom retirement for those who have become superannuated on some sort of civil pension should be provided, and this class comprises the different civil employees of the Bureau. Consequent on the fact that the Coast and Geodetic Survey is a very old branch of the Government service (it having recently rounded out a century of activity) it has on its rolls civil employees who have reached the ages when they should be retired on account of superannuation.

The matter of retirement of civil employees in the Government service has been agitated for years in this country, and while retire-

ment of superannuated employees under varying conditions and at various rates of pay is in effect in many foreign countries, the principle has not been acted upon in this country except to a limited extent in a few services. It is not urged that the Coast and Geodetic Survey is on any different status from other governmental branches in this respect so as to entitle its employees to special consideration, but from the fact that it is such an old service it has on its rolls a considerable number of employees who have reached such ages that their abilities are impaired and they should be retired. Their pay has been so small and the cost of living has been such that if their salaries ceased they become dependent. The work of the Bureau would be greatly accelerated if there were some general provision for the retirement of the employees of the Coast and Geodetic Survey who have reached ages when they can not keep pace with the needs of the Government.

PROPER HOUSING FOR THE EFFICIENT OPERATION OF THE BUREAU.

Year by year mention has been made of the fact that the operation of the Bureau is fettered and restrained because of the handicap of quarters that restrict at every turn the fullest accomplishments. It is not feasible and practicable to try to make an old hotel building into an office where employees can be grouped under proper supervision and where machinery for printing charts, manufacturing and repairing surveying instruments, electrotyping copper plates, etc., can be properly installed. The limitations in size of rooms, rooms supplying proper light, sufficient number of rooms, communication between employees who have work in common and must consult common records and yet can not be grouped in one part of the building or even on the same floor of the building are restrictions that seriously retard the output of the Bureau. Too, noisy machinery must be installed in rooms contiguous to those in which are specialists engaged on work requiring the closest concentration, and the best of results can never be obtained.

However, it is recognized that with the immense burden of expense which the Government is bearing now it is no time to insist upon the expansion of these expenditures in the construction of a new building. Yet, these are conditions that in the interest of ultimate economy should be remedied at the earliest feasible moment.

CHAPTER III.

WAR WORK OF THE COAST AND GEODETIC SURVEY.

On May 22, 1917, an act was approved "to temporarily increase the commissioned and warrant and enlisted strength of the Navy and Marine Corps, and for other purposes." By section 16 of this act the field officers of the Coast and Geodetic Survey, then under the designation of assistants and aids, were directed, by and with the advice and consent of the Senate, to be commissioned as officers in the Coast and Geodetic Survey under designations therein specified.

By this same act the President was authorized "whenever in his judgment a sufficient national emergency exists to transfer to the service and jurisdiction of the War Department and the Navy Department such vessels, equipment, stations, and personnel of the Coast and Geodetic Survey as he may deem to the best interest of the country." Provision is also made for the return to the Coast and Geodetic Survey of such vessels, equipment, stations, and personnel when such emergency ceases in the opinion of the President.

In the exercise of this authority, the President issued an Executive order on September 24, 1917, by which the following vessels and the personnel thereon were transferred to the service and jurisdiction of the Navy Department: *Surveyor*, *Bache*, and *Isis*.

And on May 16, 1918, another Executive order was issued transferring the following vessels and the personnel thereon to the service and jurisdiction of the Navy Department: *Patterson* (temporarily renamed U. S. S. *Forward*) and *Explorer*.

On March 16, 1918, at the request of the Secretary of War, the Superintendent of the Coast and Geodetic Survey was granted "leave of absence" from his duties in the Coast and Geodetic Survey, and commissioned in the War Department.

OFFICERS OF THE SURVEY ON MILITARY DUTY IN THE WAR AND NAVY DEPARTMENTS.

By Executive order of September 24, 1917, and others of subsequent dates, officers and employees of this Bureau were transferred to and commissioned in the War Department and the Navy Department. Members of the Coast and Geodetic Survey are now commissioned in the War Department and the Navy Department as follows:

In the War Department:

Col. E. Lester Jones.
Maj. William Bowie.
Capt. E. P. Ellis.
Capt. C. V. Hodgson.
Capt. E. H. Pagenhart.
First Lieut. Rowland K. Bennett.
First Lieut. Frank S. Borden.
First Lieut. P. B. Castles.
First Lieut. E. F. Church.
First Lieut. W. H. Clark.
First Lieut. George D. Cowie.
First Lieut. I. M. Dalley.
First Lieut. Ernest W. Eickelberg.
First Lieut. Bert C. Freeman.
First Lieut. Harry T. Kelsh, jr.
First Lieut. W. D. Lambert.

First Lieut. W. J. McKenzie, jr.
First Lieut. C. F. Mourhess.
First Lieut. Harold W. Pease.
First Lieut. Payson A. Perrin.
First Lieut. Howard S. Rappleye.
First Lieut. Ernest E. Reese.
First Lieut. Max O. Witherbee.
First Lieut. Andrew C. Witherspoon.
Second Lieut. J. W. Cox.
Second Lieut. Benj. Galos.
Second Lieut. Herbert H. Grummann.
Second Lieut. George R. Hartley.
Second Lieut. Robert J. Hole.
Second Lieut. R. D. Horne.
Second Lieut. Fred E. Joekel.
Second Lieut. R. A. Wheeler.

In the Navy Department:

Lieut. Commander Arthur Joachims,
 Lieut. Commander W. S. P. Keyes.
 Lieut. Commander Robert F. Luce.
 Lieut. Commander W. E. Parker.
 Lieut. Commander J. H. Peters.
 Lieut. H. R. Bartlett.
 Lieut. Leo. O. Colbert.
 Lieut. Francis G. Engle.
 Lieut. Nicholas H. Heck.
 Lieut. A. S. Hallberg.
 Lieut. Francis H. Hardy.
 Lieut. Wilmer O. Hinkley.
 Lieut. Thomas Jamleson.
 Lieut. Paul V. Lane.
 Lieut. Gardiner Luce.
 Lieut. R. R. Lukens.
 Lieut. Thos. J. Maher.
 Lieut. Jas. E. Marsh.
 Lieut. K. E. Nelson.
 Lieut. Raymond S. Patton.
 Lieut. Clifford G. Quilllan.
 Lieut. Leroy P. Raynor.
 Lieut. Gilbert T. Rude.
 Lieut. H. A. Seran.
 Lieut. Roscoe P. Strough.

Lieut. Paul M. Trueblood.
 Lieut. Eustace S. Walker.
 Lieut. J. T. Watkins.
 Lieut. Paul C. Whitney.
 Lieut. Leo C. Wilder.
 Lieut. (j. g.) Kenneth T. Adams.
 Lieut. (j. g.) Stanley T. Barker.
 Lieut. (j. g.) C. T. Bussell.
 Lieut. (j. g.) C. N. Conover.
 Lieut. (j. g.) Harold A. Cotton.
 Lieut. (j. g.) Arthur J. Ela.
 Lieut. (j. g.) A. L. Giacomini.
 Lieut. (j. g.) L. D. Graham.
 Lieut. (j. g.) Chas. K. Green.
 Lieut. (j. g.) M. E. Levy.
 Lieut. (j. g.) Geo. C. Mattison.
 Lieut. (j. g.) Raymond V. Miller.
 Lieut. (j. g.) O. H. Paddison.
 Lieut. (j. g.) F. L. Peacock.
 Lieut. (j. g.) Ray L. Schoppe.
 Lieut. (j. g.) Wm. Weidlich.
 Ensign Geo. L. Bean.
 Ensign Geo. H. Durgin.
 Ensign Fritz C. Nyland.
 Ensign R. C. Overton.
 Asst. Surg. G. E. Marchand.

The total personnel from the Coast and Geodetic Survey in the War Department and the Navy Department is as follows:

In the War Department:

Commissioned officers (Coast and Geodetic Survey commissions)-----	25
Other officers-----	26
Men-----	58
Total-----	109

In the Navy Department:

Commissioned officers (Coast and Geodetic Survey commissions)-----	42
Other officers-----	10
Men-----	79
Total-----	131

This total of 240 members from the Coast and Geodetic Survey in the military branches is 30 per cent of the entire personnel of the Coast and Geodetic Survey.

The energies of the personnel remaining with the Coast and Geodetic Survey have been directed almost wholly to the assistance of the military branches of the Government. Practically all the parties in the field on geodetic work have been for the purpose of securing results requested by the War Department, and many special confidential surveys have been made by the hydrographic parties for the Navy Department.

In the Washington office of the Bureau attention has been given to the needs of the military branches for which special computations have been made and special maps and charts produced. Much of the time of the instrument shops has been devoted to repairing sextants and instruments needed by the Navy Department and to the designing and perfection of new instruments and devices for the military authorities. A notable production by the Bureau for the military authorities is a treatise on the Lambert Conformal Projection. This is the projection on which the battle maps in France are based. There was no satisfactory treatise in existence, not even in French,

with which to meet the large and constant demand for information concerning it for Army officers and others interested in war maps, and to supply this need the treatise was prepared in this office. The demand for it has been large, especially from the Army.

The officers of the Coast and Geodetic Survey who have remained with the Bureau have acted in an advisory capacity on many military commissions, boards, etc.

The officers who have not been transferred and the other employees who have not become identified with the Army or Navy, remaining with the Coast and Geodetic Survey, both at the Washington office and in the field, are performing duties that are identical, as far as importance is concerned, with the military forces that are both on land and sea.

From the fact that the Coast and Geodetic Survey is an arm of the Government which is now contributing its entire efforts in war activities, it will be readily appreciated that it is as necessary to have a sufficient number of the personnel remaining with this Bureau, so as to keep it efficiently active.

There are men in this Bureau who feel that they should be at the front. It has been most difficult to discriminate in transferring some to the Army and some to the Navy, and others having to remain at home. However, it should be clearly understood and certainly bring a large amount of satisfaction of mind to those who have remained in the Bureau and have simply been held here because their services are indispensable and their work bears exactly the same importance in connection with the war as those services are literally utilized at the front.

RECENT LEGISLATION ENACTED AFFECTING THE COAST AND GEODETIC SURVEY.

The following is a summary of legislation contained in the sundry civil act of July 1, 1918, affecting the Coast and Geodetic Survey:

Among the important pieces of enabling legislation for the Bureau is the authorization of the payment of not to exceed \$1 a day as extra compensation to employees of the different stations of the Lighthouse Service while observing tides or currents. Lightships are peculiarly well situated in positions where it is desirable to collect tide and current data, but such observations are not part of the duty of the Bureau of Lighthouses and in the past could not justly be imposed on the light keepers of that Bureau without some additional compensation, and the appropriations for the Coast and Geodetic Survey could not be expended to recompense them for such additional duties without this authorization. From the results of data collected by lightships it is expected that predictions can be made which will be of direct benefit to navigators and go far toward saving many vessels from loss through inadequate knowledge of the direction and strength of the ocean currents.

This act also authorized the Bureau to purchase supplies or procure services in the open market in the manner common among business men where the amount of the purchase does not exceed \$50. Instances are numerous in the past where the necessity of securing competitive bids for small items have materially delayed the progress of

field work, and such required procedure has actually cost the Government more than the value of the article purchased.

Other items are the authorization of the running of lines of precise levels in the interior of Alaska; the employment of draftsmen in the preparation of plans and specifications for vessels; and the reimbursement under rules prescribed by the Secretary of Commerce of officers of the Bureau for food, clothing, medicines, and other supplies furnished for the temporary relief of distressed persons in remote localities and to shipwrecked persons temporarily provided for by them.

Three important items of additional appropriation for the Bureau are contained in the act. One is an appropriation of \$50,000 for a new vessel to cost not exceeding \$354,000. Another is the appropriation of \$50,000 for a new motor-driven vessel, including equipment, to replace the *Taku*. The *Taku* was condemned as unseaworthy and sold. The third is for four or more new launches, including their equipment, \$62,500. The two new vessels are for much-needed surveys of the waters of Alaska, and the launches are for use in wire-drag surveys. In the past launches for these surveys have been procured at a necessarily excessive rental, owing to the fact that they were taken from other industries, and they have been generally unsatisfactory for wire-drag work because they were not especially designed for the purpose.

Provision is made for some additional technical employees of the Bureau whose services are used in the preparation and production of charts issued by the Bureau, and which are so largely used by the Navy Department, vessels of the War Department, merchant marine, and the new vessels being built by the Shipping Board.

Part III.—STATEMENT FOR THE PAST YEAR OF ACCOMPLISHED FIELD AND OFFICE WORK, ACCOMPANIED BY ILLUSTRATIONS, AS REQUIRE BY STATUTE, SHOWING THE PROGRESS MADE, ETC.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY.

The division of hydrography and topography has supervision of the hydrographic and topographic work on the coasts of the United States and insular possessions; the vessels of the Survey, including their construction, maintenance, repair, equipment, personnel, and office records; the field stations, including the office of the Director of Coast Surveys, at Manila; the completion in the office of the field records of the surveys. the compilation of the coast pilot in the field and office; and the tide and current work of the Survey, including the compilation of the tide tables.

Orders and instructions for the personnel and parties engaged in the above-named work, and the necessary correspondence, are prepared in the division of hydrography and topography. The division includes five sections, namely, field work, field records, vessels and equipment, coast pilot, and tides and currents.

Following is a general statement of the progress of the field and office work. Detailed statements of the work are given in the reports of the chiefs of sections and parties:

MILITARY WORK

During the fiscal year 1918 practically all of the topographic, hydrographic, and wire-drag work of the Bureau was done at the request of the Navy Department to meet urgent military needs. Work not done at the request of the Navy Department was undertaken only when its urgent need and importance were determined.

The Bureau and its field parties cooperated closely with the Navy Department. At Washington, D. C., frequent consultation and correspondence with the various bureaus of the Navy Department were had relative to the work that was requested. In the field, the parties cooperated closely with the local naval commandants, the commanding officer of the fleet, or other naval authority.

Five of the larger vessels of the Bureau, together with their personnel, were transferred to the Navy Department by Executive order. These vessels required but little work to fit them to meet the needs of the Navy Department after the transfer.

FIELD WORK, ATLANTIC COAST.

The steamer *Bache* was at Norfolk repairing and outfitting for field work during July, 1917. At the request of the commandant of the naval base, Hampton Roads, Va., confirmed by the Secretary of the Navy, the *Bache* was employed from July 24 to September 23, 1917, on a detailed hydrographic and topographic survey of the

naval base, on which should be based very extensive improvements intended at that point.

The steamer *Isis* was repairing at Baltimore, Md., during July and August, 1917. During September the vessel made an inspection trip on the New England coast, by direction of the Secretary of Commerce.

On July 1, 1917, the steamer *Surveyor* was at Portsmouth, N. H., arranging for receiving certain launches and fittings that had been built for that vessel. The vessel then proceeded to Tompkinsville, Norfolk, and Washington, arriving at the last-named place on July 24. At Washington, the vessel was inspected by the naval authorities, the surveying instrumental outfit was placed on board, and arrangements were made for transferring the vessel to the Navy Department.

On September 24, 1917, the steamers *Surveyor*, *Isis*, and *Bache*, with their complements of officers and men, supplies, and equipment, were transferred to the Navy by Executive order, in conformity with law.

The steamer *Hydrographer* completed the comprehensive survey begun the previous year of the entire seacoast of Mississippi and Alabama, including during the present fiscal year Mississippi Sound, Mobile Bay, and the seaward approaches. Detached shore parties were organized for this work as soon as practicable after the funds for the fiscal year became available, and these parties were continued while the work was in progress. Repairs, including the installation of a new boiler, were made to the vessel at Mobile, Ala., for about one month during the latter part of March and first part of April.

This survey developed extensive changes from the published charts, which were based on surveys made about 70 years before. The survey of Mobile Bay was made at the request of the Navy Department and commercial interests, and enables the Bureau to publish an up-to-date chart showing the very extensive commercial development now in progress.

The survey of Mobile Bay was completed at the end of May and the vessel proceeded to Norfolk, Va., arriving on June 13. After a consultation with the commanding officer, instructions were issued for the work in the lower part of Chesapeake Bay, embracing the main channel of the bay and approaches to Hampton Roads, to meet the needs of the Navy Department. At the end of the month signals and tide staffs had been erected and sounding work has been begun.

The schooner *Matchless* completed a comprehensive resurvey of the easterly side of Pamlico Sound from the vicinity of Cape Hatteras to the south end of Roanoke Island. The topography of the inner and outer shore lines of the outer beach was completed; also the hydrography, with the exception of a strip of the sound about 8 miles long between New River Inlet and Oregon Inlet.

The vessel also completed certain surveys previously done by the same vessel in Croatan and Roanoke Sounds. These surveys were made to bring our charts up to date and also to meet the needs of the Lighthouse Service. The previous general surveys of the region had been made about 70 years before.

Owing to the very severe winter the *Matchless* en route from Roanoke Island to Elizabeth City was caught in the ice and held

from about December 24 to January 17, and was then towed to Elizabeth City. On the 29th she was taken to Norfolk. During February, March, and April the vessel was repaired at Norfolk and outfitted for field work.

Soundings were made by the vessel to meet the needs of the Navy Department around the coal piers at Newport News and in the Newport News dredged channel in Hampton Roads.

During May and June the *Matchless* was employed in York River on surveys requested by the Navy Department. These surveys included a complete survey of the Mattaponi River from the bar at its entrance to the shipyard at Yorktown; also a verification of the hydrography of the river from Gum Point to York Spit Lighthouse.

Wire-drag party No. 1 completed the wire-drag survey of the approaches to Portsmouth Harbor, N. H., to meet the needs of the Navy Department. This party cooperated closely with the local naval authorities, and performed certain special surveys requested by them. The work was continued to September 24, 1917, when certain officers of the party were transferred by Executive order to the Navy Department.

In the spring of 1918 the party outfitted at Kittery Point, Me., and on May 6 began a survey on the west coast of Block Island to meet the needs of the Navy Department. This special work was undertaken to develop and make safe a submarine trial course, and the work included current observations and soundings over a very considerable area on either side of the trial course and a wire-drag survey for a distance of $2\frac{1}{2}$ miles westward from the 10-foot curve on the west side of the island.

Along the west side of the south half of the island wire-drag work was extended from the 10-foot curve to a junction with the wire-drag work previously completed there. Many uncharted bowlders and dangers to navigation were located by this party, and the results of this work were furnished to the Navy Department. The work of this party was delayed by reason of the inability to secure efficient launches for the purpose.

Wire-drag party No. 2 surveyed Block Island Sound and the approaches to Narragansett Bay to meet the needs of the Navy Department. While employed on this work the party executed a number of special surveys at the request of the Navy Department, including a comprehensive survey of Sakonnet River and a wire-drag survey of certain areas between Bartlett Reef and The Race. The party was disbanded on December 4, 1917.

In the spring of 1918 the party was organized and the launches equipped at Wickford, R. I., and on April 15 began wire-drag work in Long Island Sound requested by the Navy Department. The first work done by this party was a comprehensive survey of the trial course off Port Jefferson, L. I., including triangulation lead-line hydrography, and a wire-drag survey.

From May 7 to 24, inclusive, the party was employed from Stonington, Conn., as headquarters, on a wire-drag survey in the east end of Long Island Sound. This party was then transferred to the coast of Maine and arrived on June 1.

From July 1 to September 23, wire-drag party No. 5 was engaged on a wire-drag survey of the passage across the Florida Reefs

between Rebecca Shoal Lighthouse and Dry Tortugas, Fla. Frequent high winds and strong currents, together with inadequately powered launches, interfered seriously with the progress of the work.

It having been found impracticable to secure launches for wire-drag work in Porto Rico, wire-drag party No. 5 was organized during the month of June for the work in Block Island Sound requested by the Navy Department. At the close of the month the necessary launches had been secured and the party was ready to begin work early in the next fiscal year.

A shore party was employed from July 23 to September 24, 1917, on a revision of the triangulation and topography of the north shore of Long Island from Northport to Kings Park.

A party using chartered launches revised the hydrography in the south approaches to Cape Cod Canal from August 1 to September 30, 1917. The party was then transferred to Plymouth Harbor, Mass., to complete the revision of the hydrography in that vicinity. This work was completed on November 15.

A party using chartered launches continued a comprehensive tide and current survey, begun the previous fiscal year, of the easterly half of Long Island Sound eastward from New Haven. Currents were observed for 51 hours each at important stations in the sound and the principal tributaries. Automatic tide gauges were maintained at selected stations during the work, staff gauges were operated for short periods at numerous other stations, and approved bench marks were established for all stations and connected up with all previous work of this character which embraced a number of years' observations. This work was continued until November 3, when the party was disbanded.

The field revision of Atlantic Coast Pilot, Section A, which covers the coast from the northeast boundary to Cape Cod, was done between July 13 and October 27, 1917; and that of Atlantic Coast Pilot, Section B, which covers the coast from Cape Cod to New York, was done between July 14 and September 24, 1917.

For use as a trial course for naval vessels, a course 1 mile long was laid out at Alexandria, Va., in November, 1917.

A survey of the Virgin Islands having been requested by the Navy Department, a party left the office on January 31, 1918, and was employed on triangulation and topographic surveys of the islands for the balance of the fiscal year. This party is cooperating with the naval officials at St. Thomas, and, in addition to the general survey requested by the Navy Department, has made a number of small surveys especially requested by the local naval officials.

Field stations, each in charge of an inspector who is a field officer of the Bureau, were maintained at Boston from January 7 to June 30, 1918; at New York City during the fiscal year; at Galveston from July 1, 1917, to January 14, 1918, when the office space was taken over by the District Court; and at New Orleans from March 1 to June 30, 1918.

At each field station there is maintained a stock of charts and other publications of the Survey for consultation and for sale. The officer in charge has for his principal duties an inspection of the navigable waters within his district, for the purpose of keeping the charts and other nautical publications of the Coast and Geodetic Survey cor-

rected to date and the furnishing of information relative to our coasts to the public.

The routine duties of the field station are handled by a clerk. In addition to the inspection duties of the field station, the following special assignments were made to the inspectors during the year:

The inspector at Boston is a member of the Mississippi River Commission and attended several meetings of the commission during the year. The inspector also made a field examination of the coast between Gloucester and Boston, preparatory to undertaking the field work of making a revision of the triangulation and topography of this locality for use on a large scale chart of this area which is urgently needed, especially of the important harbor of Lynn, Mass.

The inspector at New York had charge of the exhibit for the Bureau at the meeting of the Southern Commercial Congress from October 15 to 17, 1917; also at the National Motor Boat Show held at New York city during the week beginning January 20, 1918.

To meet the needs of the Navy Department for the location of certain stations in connection with the Proving Grounds at Sandy Hook, the inspector at New York executed triangulation along the coast of New Jersey during April and May, 1918.

At the request of the United States Engineer's office at Galveston, Tex., the inspector of the Bureau at Galveston executed a survey of Brazos Santiago for purposes of improvement. The work comprised triangulation, topography, and hydrography, and was executed from August 7 to 31, 1917.

FIELD WORK, PACIFIC COAST.

A shore party was employed from July to October, 1917, on a survey begun the previous fiscal year of the triangulation, topography, and hydrography of the important Lake Washington Ship Canal and Duwamish Waterway, which had been recently completed at Seattle Harbor.

Field stations of the Survey, each in charge of an inspector who is a field officer of the Bureau, were maintained at San Francisco and Seattle during the year.

Each field station maintained one of the regular tide stations of the Bureau throughout the year, obtaining a continuous record of the time and height of the tide with an automatic tide gauge.

The field station at Seattle served as headquarters for the field parties operating in Washington and Alaska, and rendered valuable assistance to the field parties in the purchase of outfit and supplies, repairing the vessels, and securing men.

A field officer of the Bureau began an inspection trip during June along the west coast of the United States, to enable the Bureau to keep in close touch with the conditions of the surveys on that coast, so that steps can be taken to meet the immediate needs under present conditions. This officer also inspected the chart agencies of the Bureau on that coast.

FIELD WORK, ALASKA.

The steamer *Patterson* during the summer of 1917 was employed in southeast Alaska on surveys in the approaches to Cross Sound. The triangulation was extended from Cross Sound southward

through Lisianski Inlet, Lisianski Strait, and the outer coast, to Portlock Harbor, forming an important closure in the loop of triangulation around Chichagof Island. The topography and hydrography of Lisianski Strait and Inlet were completed.

The ship executed offshore hydrography in the westerly approach to Cross Sound for a distance of 27 miles off the coast and extending about 60 miles along the coast. It was not possible to complete this work as fully as intended, but the information thus obtained is an important addition to our information for the use of navigators in this important approach from westward to southeast Alaska.

Trouble was had in holding an efficient crew on the vessels for the entire season, and only by shifting a part of the crew from the *Explorer* to the *Patterson* was it possible to keep the work going. The work was closed on September 23, and after storing the *Cosmos* and launches at Metlakatla the ship returned to Seattle on October 13. The vessels were laid up in Lake Union with a reduced crew where repairs were made to the vessel. On May 16, 1918, the vessel was transferred to the Navy Department by Executive order.

The steamer *Explorer* during the summer of 1917 was employed in southeast Alaska on a comprehensive survey of the outer coast from Cape Muzon to Meares Passage. Owing to the difficulty of securing and holding a crew for the vessel this work could not be economically prosecuted.

The vessel therefore closed work on July 19, and a part of the officers and crew were transferred to the steamer *Patterson*. The vessel then returned to Seattle on August 18, and was then laid up in Lake Union, after certain minor repairs had been made. The *Explorer* was transferred to the Navy Department on May 16, 1918, by Executive order.

The steamer *Taku* was assigned to survey the northwesterly end of Prince William Sound in regions where commercial development was most active. Owing to the difficulty of securing and holding an efficient crew and the constant trouble with the engine of the vessel, it was impracticable to continue work throughout the summer. The vessel surveyed the entrance to Port Nellie Juan and all of McClure Bay. Work was closed on August 22 and the party returned to Cordova. The vessel was then inspected by United States steamboat inspectors and was condemned as no longer economically fit for the survey work of the Bureau. The vessel was therefore sold to the highest bidder on December 13, 1917.

The steamer *Yukon* was laid up at King Cove, Alaska, during the entire year. In the summer of 1917 a party of the Bureau repaired the vessel and made her secure while laid up and housed over for the winter. Owing to the difficulty of securing and holding an efficient crew for the vessel no field work could be done.

During the summer of 1917 two wire-drag parties were employed on a survey of the main passages forming the principal inside route through southeast Alaska. Difficulty was had in obtaining and holding efficient parties, but a satisfactory season's work was accomplished; in addition to the wire-drag work, the parties carried out a revision of the topography of the passages covered by the wire-drag survey. The triangulation for the same areas was mostly done by separate parties.

Wire-drag party No. 3 extended the work in Frederick Sound from its easterly end in the vicinity of Dry Strait to Turnabout Island and thence northward to the north side of the entrance to Fort Houghton. The work was continued until September 27 and the party returned to Seattle on October 6. A number of the officers of the party were then transferred to the Army and Navy.

Wire-drag party No. 4 completed the survey of the principal route through Stephens Passage, Saginaw Channel, Favorite Channel, and Lynn Canal from Point Hilda to Point Bridget. The work was continued until September 12, and the party returned to Seattle on September 19. A number of the officers of the party were then transferred to the Army and Navy.

In the spring of 1918 four officers of the Bureau, using the equipment of wire-drag party No. 3, were sent to Anchorage, Alaska, to make a survey of Knik Arm in the approaches to the railroad terminal at Anchorage, at the head of Cook Inlet. This survey had been requested by the Alaskan Engineering Commission to insure safety for vessels carrying supplies to and from Anchorage. The party arrived at Anchorage on May 3, but the equipment did not arrive until May 19.

The Alaskan Engineering Commission actively cooperated in the organization of the party, and enabled it to secure hands and launches sufficient to prosecute the work satisfactorily.

A comprehensive wire-drag and hydrographic survey was then begun and was in progress at the close of the fiscal year. A survey of the town site of Anchorage was also made. In connection with this survey an automatic tide gauge was installed at Anchorage, and tidal observations will be continued throughout the summer and fall until the formation of ice, in order to furnish data to enable the Bureau to publish full tidal prediction in the Tide Tables for the use of mariners for this important terminal.

When the *Patterson* and *Explorer* were transferred to the Navy Department on May 16, 1918, the commanding officer of those vessels withheld those men from the complement of the vessels who were not available for enlistment in the Naval Reserve to form a nucleus for a crew for the launch *Cosmos*. At the close of the fiscal year arrangements had been made for the repairing and placing of the *Cosmos* in commission and the party was en route to southeast Alaska.

FIELD WORK, PHILIPPINE ISLANDS.

The work of the survey in the Philippine Islands is executed under the direction of the Director of Coast Surveys, an officer of the Coast and Geodetic Survey, who, acting under authority of the Superintendent, makes plans for the work, issues detailed instructions to the field parties, and also has charge of the field station at Manila. The expenses of the work are met partly from the appropriations for the Coast and Geodetic Survey and partly from funds provided by the Philippine government, which also furnishes four vessels for surveying purposes. One steamer, the *Pathfinder*, is furnished by the Coast and Geodetic Survey.

The five vessels of the Survey have been kept at work in the field as continuously as possible, being absent from the field only for the

purpose of renewing coal and other supplies and having the necessary repairs made.

One of these, the small steamer *Research* of 96 tons register, was returned by the Bureau to the Philippine government, it having determined that the vessel is not sufficiently seaworthy to continue on the surveys of the exposed localities remaining to be done in the islands.

On March 19, 1918, the steamer *Marinduque* was temporarily transferred to the insular government for use as a transport among the islands. This vessel will be returned to the Coast and Geodetic Survey as soon as full complement of officers of the Survey can be sent to the Philippine Islands.

The steamer *Pathfinder* continued inshore and offshore topographic and hydrographic surveys in the vicinity of Polillo Island until October 18, when the weather conditions through the change of monsoons became unfit for further work in that exposed locality. The vessel then returned to Manila for extensive repairs. These repairs were done at the naval station at Olongapo from December 12, 1917, to April 20, 1918. After obtaining the necessary supplies at Manila the vessel then proceeded to the field of work on the east coast of Palawan Island where the field work was continued to the end of the fiscal year.

The steamer *Fathomer* was at Manila from July 1 to 12 for supplies. Inshore and offshore hydrographic work was then taken up in the vicinity of Polillo Island in conjunction with the steamer *Pathfinder*. The field work was discontinued about the middle of October due to the change of monsoons, making it impracticable to work in that locality for a longer time. The vessel was at Manila repairing from October 19 to November 26 and from March 2 to March 11, and otherwise was employed on offshore hydrographic surveys around Busuanga and Cuyo Islands in the northerly part of the Sulu Sea until the end of the fiscal year.

The steamer *Romblon* was at Manila from July 7 to August 1, from October 14 to November 16, and from January 19 to April 18, outfitting and receiving the necessary repairs. Otherwise the vessel was employed during the fiscal year on combined surveys of the southeast coast of Palawan Island.

The steamer *Marinduque* was employed on combined surveys on the east coast of Palawan from July 16 to September 22 and from October 18 to December 19. The vessel was repaired and outfitted at Manila as necessary, and on March 19 was temporarily transferred to the insular government and the officers of the Coast and Geodetic Survey were assigned to other duties.

The steamer *Research* completed from July 1 to August 24 the survey of Manila Bay begun the previous fiscal year. The vessel was then laid up and on January 4, 1918, was transferred back to the insular government.

A very gratifying result of the field work in the Philippine Islands for the fiscal year is the completion of the secondary triangulation extending throughout the island of Palawan. This will enable the Bureau to prosecute its surveys around that island in a systematic manner so that all work will be on the same datum, and further insures that all work executed in that locality will be done in a permanent manner. The hydrographic and topographic surveys on

the east side of the island based on this triangulation have made excellent progress.

An exhibit consisting of maps, charts, and illustrations, showing the work accomplished by the Coast and Geodetic Survey in the Philippine Islands, was made at the annual carnival at Manila from February 2 to 10, 1918.

SECTION OF FIELD WORK.

This section is a part of the division of hydrography and topography. Its principal duties are to supervise the topographic and hydrographic surveys, and to coordinate and standardize the work of the various field parties with a view to having a complete and continuous survey of the coast.

When general surveys of the coast are in progress, new surveys in remote localities are to be made, or revision surveys contemplated, all data pertaining to the locality in which the work is to be done are assembled. From a careful review of these data, the best methods of accomplishing the work are determined and the memoranda for instructions prepared accordingly. General supervision is given to the topographic and hydrographic work as it progresses, and, through reports and sketches received monthly from each party, close touch is kept with the field work.

During the year there were data collected and itemized memoranda prepared for 20 sets of instructions for field work. These embraced a careful study of the existing surveys, the nature of the bottom, the reviewing of reports upon previous work, and the required closeness of the work needed to obtain a comprehensive survey of the locality in question.

Original field sheets covering areas where changes frequently occur and where preliminary surveys only have been made were reviewed, in order to formulate plans for performing the field work necessary to bring the charts up to date.

As time permitted, completed field sheets were reviewed in the section preparatory to recommending them for the Superintendent's approval. There were 90 hydrographic sheets closely inspected, and memoranda bearing on the work were prepared for insertion in the descriptive report accompanying each sheet.

SECTION OF FIELD RECORDS.

The principal duty assigned to the section of field records is the inspection of the data submitted by the field parties, and their completion for publication and the files. This inspection of the field results has been extended to cover preliminary studies of miscellaneous reports and records for use in formulating detailed plans for the conduct of the work in the field, and takes into consideration both the means available and the general program of operations.

In connection with the review and analysis of the results submitted by the field parties, there are noted the imperfections of present means and methods of conducting our operations, with a view of correcting these shortcomings in subsequent work. There are also developed and reported methods and treatment and suggestions for use in publishing the collected field data.

In addition to the final review of the field results, examination of the work as it progresses is made, and preliminary instructions modified to meet the changing requirements of the work as it is developed.

The section has handled many miscellaneous requisitions and assignments.

During the months of April and May, 53 original hydrographic sheets were examined and memoranda prepared for insertion in the descriptive reports of the sheets.

As a part of his duties as a member of the personnel board, the chief of the section prepares examination papers for promotion of such officers as may be recommended by the board.

On June 11, 1918, the chief of the section was detached and assigned to duty as inspector of construction of the proposed new vessels for the Bureau, authorized in the sundry civil act of July 1, 1918, and no officers were available to carry on the routine work of the section after that date.

SECTION OF VESSELS AND EQUIPMENT.

The section of vessels and equipment has charge of the maintenance of the vessels of the Survey, and supervision is given to all estimates for repairs and the purchase of new equipment. Careful analysis is made of all estimates with a view to standardizing the equipment and supplying each vessel with an outfit adapted for the class of work upon which the vessel is to be engaged.

Inspection of each vessel of the Survey is made once a year by the chief of section when conditions will permit, except vessels in Alaska and the Philippine Islands. Inspections of the vessels in Alaska and the Philippine Islands are made by officers of the Bureau in those localities, and reports forwarded to the office for consideration.

In connection with the supervision of repairs, equipment, etc., of the vessels of the Survey, consideration was given to the preparation of plans and specifications for new vessels and wire-drag launches. The types of launches best suited for the survey work were decided upon, but final plans and specifications were not completed, owing to a lack of an appropriation for the work.

Contracts for repairs and the charter of all launches hired for the season's work were inspected and prepared for the approval of the Superintendent.

Owing to the transfer of the chief of the section of vessels and equipment to duty with the Navy, on September 24, 1917, the work of this section was done after that date under the direction of the chief of the section of field work.

On July 1, 1917, there were 13 vessels used by the Coast and Geodetic Survey for surveying duty. During the year 5 of these have been transferred by Executive order to the jurisdiction of the Navy Department for the period of the war, one being unfit for further service in the Bureau was condemned and sold, and two were returned to the jurisdiction of the insular government in the Philippine Islands, one of them temporarily for duty as a civil transport.

COAST PILOT SECTION.

During the year this section carried on field work on the North Atlantic coast, and as a result of the field work two coast pilots,

Atlantic Coast Pilot, section A, from Eastport, Me., to Cape Cod, and Atlantic Coast Pilot section B, from Cape Cod to Sandy Hook, were compiled. Both volumes are at present in the hands of the printer. Numerous chart corrections collected during the course of the field work were submitted.

These volumes when received will complete the issue of all coast pilots on the Atlantic and Pacific coasts of the United States and of Alaska in the new octavo form.

Reprints were obtained during the year of Atlantic Coast Pilots, parts 1, 2, 3, and 4, section C and section D. Supplements for five volumes and such correction sheets as were necessary to keep the information in all volumes up to date were issued.

The record of the issue of coast pilots in recent years is interesting as indicating the usefulness of these publications. As these volumes are sold at a price sufficient to defray the cost of printing (50 cents), it is obvious that the number sold furnishes an accurate measure of the public demand. The following is the record of the issue for the fiscal years from 1911 to date:

1911.....	2, 720
1912.....	3, 792
1913.....	3, 797
1914.....	4, 148
1915.....	4, 016
1916.....	5, 502
1917.....	7, 952
1918.....	12, 913

SECTION OF TIDES AND CURRENTS.

Tidal observations were made throughout the year at 7 permanent tidal stations along the Atlantic coast, 3 on the Gulf of Mexico, 3 on the Pacific coast, and 1 in Alaska. In addition to these, observations were made in connection with all hydrographic surveys in the United States, Alaska, and the Philippines. Tides were observed at 119 stations during the year, the total combined length of observations being 38 years, 7 months, 4 days.

During the year all permanent tidal stations were inspected at least once, the inspection in all cases including the connection of the tide staffs of the station with the permanent bench mark by spirit levels.

The work of making a comprehensive tidal and current survey of our coasts, which was begun in the summer of 1916, was continued during the fiscal year 1918. A party in eastern Long Island Sound occupied 15 tidal stations and 46 current stations. Other parties were occupied on such work in Mississippi Sound and Mobile Bay, Gulf of Mexico, in connection with hydrographic surveys.

The purpose of the tidal survey is to obtain tidal information at important points along the coast, and the establishment of permanent tidal bench marks at all principal points along the coast, which will serve the public in all cases where a knowledge of tidal planes is required, such as for engineering operations, city and land surveys, surveys of oyster areas, and many other purposes; which will furnish hydrographic parties with standard datums; and which will afford starting and checking points for lines of precise levels.

The purpose of the current survey is to obtain definite information concerning currents in navigable channels, entrances to bays, rivers, passages, and at points along the coast, for the benefit of navigators.

The tidal survey is carried on by means of two automatic tide gauges and several subsidiary staffs; current measurements are made by means of current meters, the velocity being obtained at various depths at each station, and also by means of a vertical pole float.

At the instance of the Navy Department, current observations were made at the following places: The Race, between Little Gull Island and Fishers Island, N. Y., where the velocity was measured at various depths from near the surface nearly to the bottom of the channel; at Port Jefferson, N. Y.; and on the west side of Block Island, R. I.

The two tide staffs which were erected in Wrangell Strait, Alaska, for the benefit of navigation, were visited and repainted. These staffs were set with their zeros at the plane of reference used on the charts, so that navigators can read directly from the staff what correction should be applied to the soundings on the chart to give the depth of water at that time.

A special effort has been made to have newspapers in the principal seacoast cities of the country publish official tidal and related data, and a number of newspapers in Washington, Baltimore, New York, San Francisco, Seattle, and many other cities have responded.

The Tide Tables for 1918 were received from the printer in September, 1917. These tables are similar to those of the preceding year, but full predictions are given for four additional ports, namely, Savannah, Ga.; Anchorage, Cook Inlet, Alaska; Cebu, P. I., and Port Hedland, Australia. The standard port of Amoy, China, has been discontinued, leaving 81 stations for which full predictions are given. Some other minor changes were made to make the volumes more useful to navigators. The following table issues shows the increased demand for these tide tables in recent years:

Tide Tables for—	General Tide Tables.	Atlantic Coast Tide Tables.	Pacific Coast Tide Tables.	Total Issue.
1913.....	1,008	1,607	9,655	12,170
1914.....	1,126	1,634	10,882	13,642
1915.....	1,665	1,991	10,481	14,143
1916.....	1,166	2,367	10,034	13,567
1917.....	1,548	3,526	12,701	17,775
1918.....	2,818	3,496	13,635	19,949

The manuscript of the Tide Tables for 1919 was prepared and submitted for printing in three separate parts as follows:

The manuscript of the Atlantic Coast Tide Tables was prepared and submitted in advance, before the other portions of the General Tide Tables had been predicted; then the Pacific Coast Tide Tables were prepared and submitted for printing; and last of all what remained of the General Tide Tables was prepared and submitted. This arrangement is convenient to the Bureau, and under ordinary peace conditions will greatly expedite the early receipt of the volumes for issue.

The Italian Government requested this Survey to furnish predicted tides for Venice, Italy, for the two years, 1918 and 1919, which was complied with. The Government of Western Australia was furnished with copies of the proof sheets of the predicted tides for Port Hedland, Australia, for the two years, 1918 and 1919.

The computation for the graduation of the scales of the United States Coast and Geodetic Survey sounding tubes was completed in this section, and also the corrections to be applied for variations in the height of the barometer and for changes in the temperature of air and water.

The daylight saving law, which was approved on March 29, 1918, required the preparation and printing of an explanatory note to be inserted in the 1918 Tide Tables, as they were issued before the act became a law.

In addition to the extensive use by the military bureaus and Shipping Board of the tide and current tables published by the Bureau, the following data were prepared at the special request of bureaus engaged in war work.

Descriptions of 558 bench marks, currents at 84 stations, predicted tides for Hog Island, Pa., predicted tide curves for two stations, tables of sunrise and sunset, highest and lowest stages of the river at Portland, Oreg., and temperatures of the water for each month of the year at Norfolk, Va.

DIVISION OF GEODESY.

Almost the complete output of field work during the year was in the nature of war work, for the various projects were called for by the Corps of Engineers, United States Army.

Just before war was declared on Germany, in the spring of 1917, a committee on mapping was formed by the Corps of Engineers, United States Army, for the purpose of coordinating the various surveying work of the Government with a view toward having the mapping bureaus assist in the preparation of military maps in this country.

The chief of the division of geodesy of the Coast and Geodetic Survey was appointed a member of this committee to represent the Department of Commerce. This committee had several meetings, at which it was decided that the Geological Survey and the Coast and Geodetic Survey should assist the Corps of Engineers, in every way possible, in their military mapping. Accordingly, it was arranged that the geodetic field parties of the Coast and Geodetic Survey should, as far as possible, be engaged exclusively on war work. After July 1, 1917, until the end of the fiscal year the only geodetic work done which was not of immediate military value was in southeastern Alaska, where two parties were engaged on primary triangulation for several months.

The work which has been done in the past by the Coast and Geodetic Survey and the work now being done in the interior of the country in furnishing control for maps and surveys have proved of very great value to the military authorities. Without the triangulation along the coasts of the United States it would have been most difficult to have made maps of extensive regions which are to be used for defensive purposes.

It is evident, from the fact that the control work of the Coast and Geodetic Survey now in existence has been of great military value that such control should be extended rapidly into those areas of the United States which are now totally lacking geodetic surveys. There are some areas that are tens of thousands of square miles in extent

but which do not have a single triangulation station or precise level station. If topographic maps are made in such areas ahead of the control work, there will be endless confusion when an attempt is ever made to coordinate and join surveys made in various parts of a large area; there will be gaps and overlaps and offsets where any two maps join, unless the control has been carried ahead of the detailed surveying.

Aside from the desirability of having control in order to eliminate discrepancies in the maps of a large area, it is most essential that such control be prepared in advance of its needs, in order that serious delays may not result when it has been found necessary to cover unmapped areas for military purposes. This country has had very serious losses as a result of unpreparedness in military work. We should profit by the experience of the past and provide that no serious embarrassment to the Government and the country shall occur as the result of lack of maps and surveys. That the country will have to be mapped is evident to anyone who has taken any part in the commercial, industrial, and military affairs of the Nation. Not only will it be necessary to have up-to-date maps where there are large centers of population, but the mountains and plains where the population is sparse will have to be mapped for military purposes, for they may be the areas within which important military preparations may be conducted. The presence or absence of proper maps may decide the fate of a battle and it seems to be good business, as well as patriotism, to have all areas that may be of military value mapped in the near future. In fact, such mapping should be rushed. The cost of the mapping of the whole country, in such a way as to furnish results that would be of infinite value to the military establishments, would be less than the cost of a single battleship and much less than the expense of a division of soldiers for one year in time of war.

What has been said above emphasizes the need of topographic maps for military purposes. They are needed just as much for the purpose of commerce and the industries of the Nation. A nation depends for its strength not on military forces alone, but on the industries which make war materials available and the means of transportation which carry those materials to the armies of seaports where they are needed. Without maps industries are at a great disadvantage. It would be foolish to start a power plant on a river if topographic maps were not available to show the extent of a watershed feeding the river. It would also be unwise to put up a plant, or to attempt to do so, if the difficulties of road building would be such as to make the plant inaccessible, except at an enormous expense of transportation. There are many places in the United States where timber, ores of various kinds, building materials, etc., would become available if there were topographic maps by which roads for transporting such supplies could be laid out.

There is an instance of a topographic map having been made by the Geological Survey, in the State of Michigan, in cooperation with a certain railroad. As a result of the survey, a gap or pass was found among some hills which permitted the railroad to join two places at a very great reduction of cost over what the expense would have been if it had been necessary to skirt the hilly country or build the road through some pass that was much higher in elevation. It was stated by officials of the railroad that the saving to the company

in finding that one pass was much greater than the total cost of the topographic survey.

The chief engineer of one of the western railroads, several years ago, stated that the topographic surveys, as published by the Geological Survey, were of the greatest value to the railroad in question, for it was frequently possible to choose a route between terminal points by reference to the Geological Survey maps that would be far better than could possibly have been selected had those maps not been in existence.

The maps of the country to-day, published by the Geological Survey, are used also to a very great extent in the extension of the electric transportation lines in extending the network of telegraph and telephone lines as well as those carrying electrical power throughout the country.

The development of the good-roads system of the United States, which must be carried on in the very near future with the expenditure of hundreds of millions per annum, requires the rapid completion of topographic surveys in the areas not now mapped in order that the work may be done quickly and economically. The saving to the good-roads movement alone, in the period of five or ten years, will far more than pay for the topographic mapping of all unmapped areas in the United States.

This country is becoming a nation of map users and, after the war, the demand for maps is going to be far greater than ever before. Therefore it behooves the Government to provide means for rapidly mapping the unmapped areas of the country. It is hardly probable that this can be taken up to any very great extent, or at least the present effort can not be made much greater until the war is over.

A most important part of the mapping of the country is the preliminary work called geodetic control. It would be just as imprudent to try to build a house without drawing up a general plan and having the framework erected first as to make a topographic survey of a large area of the country without having established numerous points in the area whose latitude, longitude, and elevation were previously determined. A map is a poor one that does not have the proper control to enable one to refer the topographic features accurately to the universally adopted system of coordinates; that is, the plane of the Equator, the plane of the meridian through Greenwich, and mean sea level. Those three coordinates are used, respectively, for latitude, longitude, and elevation.

It will be impracticable to extend greatly the geodetic work of the Coast and Geodetic Survey during the war, and, therefore, no increase in the State survey item of the appropriation bill that is asked for the year 1920 is recommended. As soon as the war ends this policy will be changed, and a material increase in the State survey item will be asked in order that a rapid extension of the geodetic control may be made.

It is impossible to predict how much geodetic control is needed in this country. This will depend on the evolution of maps. It is known, however, that as a minimum requirement there should be a point or points whose latitude, longitude, and accurate elevation are known within about 50 or 100 miles of every place in the United States. We are far from having this minimum amount, and it

should be planned to have it as soon as practicable after the close of the war. If we have the network of triangulation and traverse lines and also a network of precise leveling lines spread over the country in such a way that no place is more than a moderate distance from primary control, then it would be very easy to furnish any Government bureau, or any State or city with primary control upon request in a very short time. It is believed that it would be economical to complete this minimum control at an early date and the fill in intermediate areas as the demands should arise.

The amount of precise leveling remaining to be done in order to meet this minimum requirement is about 12,000 miles. There are now in existence in the United States about 39,400 miles of this class of leveling. There should be about 9,000 linear miles of arcs of primary triangulation in order to furnish the latitudes and longitudes necessary to supplement the existing work to provide what may be called the minimum amount of control. There are now in existence about 15,000 miles of primary triangulation and primary traverse in this country. It should have been stated that the primary triangulation should be supplemented at times with primary traverse. Each is equally strong in furnishing primary control, but the primary traverse is only used when the country is very flat and heavily wooded, which conditions make primary triangulation very expensive.

The new horizontal and vertical control which is necessary to supplement the present work and to meet the minimum requirements will cost about \$600,000. This is a very small amount in comparison with the benefits which would accrue to the Nation. If all of the geodetic funds were expended for 10 years, we should be able to complete the control up to what we call the minimum requirements. But that work should be done sooner than in 10 years, and besides a portion of the geodetic funds are spent each year in what may be called the intermediate areas to furnish horizontal and vertical control for surveys and maps in response to requests from the Corps of Engineers, the United States Geological Survey, and other competent authorities. We may, therefore, assume that not more than \$35,000 can be spent toward completing the general project each year. Consequently it would be between 15 and 20 years before the general project could be completed. This is a condition which must be remedied, and the remedy should be provided in the form of increased appropriations for geodetic work immediately after the war.

What has been said above in regard to the need for geodetic control for surveys and maps in the United States applies equally to the territory of Alaska. There we have a large area of very valuable mineral, timber, and other classes of land which are being surveyed by the General Land Office and the topographic branch of the United States Geological Survey. Those organizations are making maps in those areas which are being developed earliest. Eventually the various maps will be joined, and then the trouble occasioned by gaps, overlaps, and offsets will present itself. Again, we may refer to the absurdity of trying to build a house without first erecting the frame. The frame for the maps and surveys in Alaska should undoubtedly be done ahead of the detailed work and funds should be provided in sufficient quantities immediately after the war to extend certain lines over the area which should have been done in the past. These lines

of primary triangulation and precise leveling are shown in two illustrations which have accompanied several reports of the Superintendent in past years. They show the sad lack of geodetic control in Alaska.

FIELD WORK.

At the end of the fiscal year 1917 a party was being organized at Harlingen, Tex., to carry on reconnaissance and signal building along the Rio Grande to the westward of Harlingen. Early in the fiscal year 1918 this party, which consisted of a reconnaissance party, under the immediate charge of the chief of party and two building parties to be engaged in the erection of signals, was completely organized. This combined party continued operations until November when the work was connected with that being carried eastward from the vicinity of Van Horn, Tex., by another party.

Automobile trucks were used as a means of transportation, several of which were borrowed from the Quartermaster, United States Army. These automobile trucks have proved conclusively to be far more efficient as a means of transportation for geodetic parties than horses and wagons, which were used for many years.

A slightly different type of triangulation signal from that usually employed in primary triangulation was used. It was somewhat along the general plan of the older signals, but very much lighter lumber was used. Considerable time and money were saved by cutting down the amount of lumber in each of the signals as the transportation was very difficult and expensive along the Rio Grande, most of the places at which signals were built being far removed from lumberyards.

Early in August, 1917, a primary triangulation party was organized which began observations immediately to the west of Harlingen and occupied stations which were provided by the reconnaissance and signal-building party. This work was continued to the westward until it joined that of another party which was working eastward from the vicinity of Van Horn, Tex.

Early in September, 1917, a reconnaissance was made to the eastward of Van Horn, Tex., along the Rio Grande, to a junction with the work of a party in the vicinity of Del Rio, Tex.

When the two observing parties on the Rio Grande completed their work, a primary base-line party was organized for the purpose of measuring bases along the arc of triangulation. This work was completed late in May, 1918.

Both observing parties and the base-line party on the Rio Grande arc used automobile trucks as the means of transportation. As in the case of the building and reconnaissance work, they proved to be the ideal means of communication over the country traversed because of the difficulty of securing water and supplies. With horses and wagons as a means of triangulation the work would have cost several times more than it did.

The Rio Grande arc was done at the request of the office of the Chief of Engineers, for the purpose of furnishing control for military topographic surveys and maps which were being made at the time the triangulation was begun.

The Chief of Engineers also requested the following lines of precise leveling in Texas: Sierra Blanca to San Antonio and New

Braunfels; Spofford to Eagle Pass; San Antonio to Laredo; San Antonio to Point Isabel, by way of Sinton, Robstown, and Brownsville; a spur line from Robstown to Corpus Christi; Sinton to Beaumont, thence to New Orleans, La.

The line from Sierra Blanca eastward had been begun by two parties during the latter part of the fiscal year 1917. These two parties continued operations until the line had been completed from Sierra Blanca to New Braunfels, by way of San Antonio. A spur line had been run from Spofford to Eagle Pass and levels had been begun on the line running southward from San Antonio toward Laredo and southward from San Antonio toward Point Isabel.

Work was continued along the San Antonio-Laredo line until it reached the latter place. The party then proceeded to Sinton, Tex., and began running a line eastward from that place toward New Orleans.

The line of levels was carried to Point Isabel by way of Robstown and Brownsville. From Robstown a spur line was run to Corpus Christi, where a connection was made with a number of tidal bench marks which had previously been established at that place.

After the completion of the measurements of the bases along the Rio Grande, a line of check levels was run over a portion of the line between Robstown and Point Isabel in order to discover an error of 1 meter which had been made in the original running of the line. When this error had been found, which proved to be an even meter, in the vicinity of San Benito, the work of this party was closed for the year.

The line of levels running from the vicinity of Sinton northeastward toward New Orleans was carried to the vicinity of Lafayette, La., and several spur lines were run from the main line to bench marks on the Gulf coast.

Work on the line running toward New Orleans was in progress at the close of the fiscal year.

The parties working in Texas on leveling used motor velocipedes as the means of transporting their parties, with the exception of one party working along the Southern Pacific Railroad, to the eastward of Houston, Tex., which used an automobile truck, supplemented by railroad trains.

The Chief of Engineers requested horizontal and vertical control in Georgia, South Carolina, North Carolina, Florida, Mississippi, and Alabama. This work had been begun in the latter part of the fiscal year 1917, when parties were organized to extend primary traverse and precise leveling northwestward from Jacksonville, Fla., and Brunswick, Ga. These parties were at work during the early part of the fiscal year 1918 and continued throughout the year, with some modifications which will be indicated below.

The work called for by the Chief of Engineers included the following lines:

(1) Primary traverse and precise leveling, Jacksonville, Fla., to Columbus, Ga.; (2) primary traverse and precise leveling, Brunswick to Columbus, by way of Macon, Ga.; (3) primary traverse and precise leveling from Albany, Ga., to Callahan, Fla., by way of Valdosta, Ga.; (4) primary traverse and precise leveling from Macon to Griffin, Ga.; (5) primary triangulation from Griffin to Atlanta, Ga.; (6) primary traverse and precise leveling from Macon

to Savannah, Ga.; (7) precise leveling from Macon to McDonough, Ga.; (8) primary traverse and precise leveling Savannah to Everett City, Ga.; (9) precise leveling, Everett City, Ga., to Yulee City, Fla.; (10) primary traverse and precise leveling from Savannah, Ga., to Norfolk, Va., by way of Columbia, S. C., and Raleigh, N. C.; (11) precise leveling, Biloxi, Miss., to River Junction, Fla.

As mentioned above, the work on the first two lines was begun during the fiscal year 1917. Those two lines and the work on lines numbered from 8 to 9, both inclusive, were completed by the end of the fiscal year 1918. The work on line No. 10 had been extended northward to the vicinity of Pontiac, S. C., and southwestward from Norfolk, Va., to the vicinity of Vaughan, N. C. The work on line No. 11 had been carried to a point a little to the eastward of Pensacola, Fla. Two combined parties operated on the Savannah-Norfolk line and one leveling party on the line No. 11.

There are given below details in regard to the organization of the parties carrying on the work in the Eastern States.

At the beginning of the fiscal year a primary traverse party was operating northwestward along the line from Jacksonville toward Columbus. A precise leveling party was operating along the same line and cooperating with the traverse party.

The work accomplished by these two parties consisted of primary traverse and precise leveling from Jacksonville to Columbus; from Albany to Callahan, by way of Valdosta; from Savannah to Everett City, and from Savannah northward to Pontiac, S. C.; also a line of precise leveling from Everett City to Yulee, Fla.

The primary traverse party that was working northwestward from Brunswick, Ga., carried the primary traverse to the vicinity of Columbus, Ga., where a connection was made with similar work done by another party and a traverse and triangulation were begun between Macon and Atlanta, Ga.

The precise leveling party operating to the northwestward of Brunswick, Ga., at the beginning of the fiscal year 1918 completed the line to the vicinity of Fort Valley, where a connection was made with a line of levels run by the party working from Jacksonville to Columbus. After making this connection a line of precise levels was run from Macon northward to McDonough.

This party completed a line of primary traverse and precise leveling from Macon to Savannah, and then moved to Norfolk, Va., and carried similar work southwestward to the vicinity of Vaughan, N. C., by the end of the fiscal year.

Early in April, 1918, field work was begun on a short arc of primary triangulation between Griffin and Atlanta for the purpose of connecting several lines of primary traverse in Georgia with the primary triangulation of the oblique arc. This work was finished about the middle of May.

In February, 1918, after the completion of the line of precise leveling from San Antonio to Point Isabel, Tex., a line was begun running eastward from Biloxi, Miss., toward River Junction, Fla. At the close of the fiscal year the line had been extended to a point about 15 miles to the eastward of Pensacola.

For the first few months of the fiscal year 1918 two primary triangulation parties carried on primary triangulation in southeast Alaska. This work had been started during the latter part of the

fiscal year 1917. The work of these parties was part of a general arc of primary triangulation which will eventually extend from Tacoma, Wash., to the crossing of the Yukon River by the one hundred and forty-first meridian. A portion of the arc in Canadian territory will be done by the geodetic survey of Canada. This is a remarkable example of geodetic cooperation between the geodetic surveys of two nations, and the results of the work will be of immense value to each of them in furnishing final control for the surveys and maps that will be made in western Canada and in Alaska.

In July, 1917, a topographic survey was made for the military authorities at Camp Meigs, D. C.

Certain surveys were also made of the grounds of the rifle range at Congress Heights, Md. This work was requested by Brig. Gen. R. D. Sims, of the District of Columbia National Guard.

A survey was made in the vicinity of Lewes, Del., for the purpose of locating a range mark of the Delaware Breakwater Trial Course. The work was done at the request of the Cramp Ship Building Co., and all expenses incident to the work, except the salary of the Coast Survey field officer, were paid by that company. The work was done in May, 1918.

Late in October and early in November a geographic position and azimuth were determined in the Aberdeen Proving Ground, Md., in response to a request from the Army officials connected with the proving ground.

A tertiary triangulation was made in upper Chesapeake Bay late in January and early in February to determine the geographic positions of a number of range towers used by the Aberdeen Proving Ground. The request for this work was also made by the officials of the proving ground.

Late in May, 1918, additional triangulation was begun in the upper Chesapeake Bay for the purpose of determining the geographic positions of a number of range towers erected by the officials of the proving ground at Aberdeen. The request was made for this work by those officials. This work at the proving ground was in progress at the end of the fiscal year.

SUMMARY OF GEODETIC WORK ACCOMPLISHED.

The total amount of geodetic work accomplished in the United States and Alaska, during the fiscal year 1918, is as follows:

	Miles
Primary triangulation along axis.....	639
Primary traverse.....	940
Tertiary triangulation along axis of scheme.....	70
Precise leveling.....	2,367

The above does not include triangulation done by any hydrographic parties, nor any work in the Philippine Islands. No precise leveling or traverse was done except that indicated above.

The geodetic work of the Survey was not done at as low cost as usual for two reasons: One is that many of the experienced officers who had been doing that work in the past were transferred to the Army and Navy and the field operations had to be done to a large extent by new engineers. This statement does not apply, of course,

to those engineers on geodetic work who had had large experience and who had not been transferred to the Army or Navy. Another cause for the higher cost of the work was the greater cost of material and the higher wages paid to the temporary employees.

Several records were made during the year on geodetic work. The most notable one was in March, 1918, when 165.4 miles of precise leveling were run in one month. This is 6 miles greater progress in a calendar month than that previously made in October, 1916. It goes without saying that this is a world's record for a single month of precise leveling. In no other country is such rapid work done on precise leveling as in the United States.

In one day of February, 1918, 22 miles of single line of leveling were completed. The previous record for a single day's work was between 20 and 21 miles.

Observations were completed at 79 primary triangulation stations on the Rio Grande arc, at an average rate of 16 stations per month, with a maximum number of 18 per month. This record is slightly greater than that made several years ago on the southern end of the ninety-eighth meridian in Texas.

Seven differences of longitude were observed in Georgia and Florida between Atlanta, Ga., and Fernandina, Fla. The sum of the seven differences agrees with the previously determined difference between Fernandina and Atlanta within 0.009 second. The correction to each of the new differences to make them fit the old results was either 0.001 or 0.002 second. This is a remarkably close agreement, and is an indication of excellent observing and instruments.

DIVISION OF TERRESTRIAL MAGNETISM.

The duties of the chief of division include preparation of plans, estimates, and instructions for the field work; the inspection of the records as they are received; recommendations regarding the purchase, construction, and repair of instruments, and the construction and alteration of observatory buildings; supervision of the office computations and preparation of results for publication; and discussion of results.

MAGNETIC SURVEY.

In the continuation of the magnetic survey of the United States, observations were made during the year at 275 stations in 21 States, of which 118 were new primary stations, 114 auxiliary stations, 34 repeat stations for the determination of secular change, and 9 new stations in old localities. Meridian lines were established when they were requested by the local authorities. The number of county seats at which magnetic observations have not been made was reduced from 163 to 138.

Observations were also made (declination only in most cases) at a number of places in Alaska and the Philippine Islands in connection with other branches of the work in the Survey.

In cooperation with the department of terrestrial magnetism of the Carnegie Institution of Washington, special observations were made at the time of the solar eclipse on June 8. Eye readings of declination were made at one-minute intervals for a period of six hours at three stations in the belt of totality, namely: Orlando, Fla.,

Mena, Ark., and Green River, Wyo. Eye readings of declination were also made for the same period at the five magnetic observatories, and values of declination, horizontal intensity, and vertical intensity at five-minute intervals were computed from the records of the magnetographs.

In further cooperation with the department of terrestrial magnetism of the Carnegie Institution of Washington, two magnetic observers of this Bureau took part in a series of observations in the vicinity of Pikes Peak, Colo., for the purpose of determining, if possible, the variation in the earth's magnetism with change of altitude. Nearly simultaneous observations were made at stations on the mountain and at numerous stations around the base at much lower altitudes. Provision was made for insuring a homogeneous series of observations by having all the observers make observations at a common station at Manitou.

MAGNETIC OBSERVATORIES.

The observatories at Cheltenham, Md., Vieques, P. R., Tucson, Ariz., Sitka, Alaska, and near Honolulu, Hawaii, were in operation throughout the year. Continuous photographic records were secured of the variations of declination, horizontal intensity, and vertical intensity. Absolute observations were made at least once a week and scale-value determinations once a month. Beginning with January, 1918, horizontal-intensity observations, as well as dip and declination, were made both in the morning and in the afternoon on the same day to secure additional data regarding the relation between the variation and absolute instruments.

All of the magnetic instruments used in the field work were standardized at Cheltenham. In addition, comparisons were made between the extra magnetometer No. 40 at Cheltenham and the standard magnetometer of the department of terrestrial magnetism of the Carnegie Institution of Washington. This magnetometer No. 40 was subsequently sent to Tucson for comparison, in order to verify the change in the relation of the Cheltenham and the Tucson magnetometers which had been indicated by the observations made at Tucson with one of the field magnetometers in October, 1917. A comparison between the Cheltenham and Sitka observatory instruments was also secured from the instruments sent to Sitka for use in the field work in the interior of Alaska. At Cheltenham the investigation of the relation between the absolute instruments and the two magnetographs was continued, but no satisfactory explanation of the outstanding differences was determined.

In October, 1917, the absolute building at Sitka was moved from the old site on the Swanson property to the lot on which the variation building stands, near the site of the old Russian blockhouse, and the necessary observations were made for determining the relation between the two sites. The erection of a new building for office quarters at Cheltenham was deferred because of conditions regarding material and labor arising out of the war.

A seismograph was operated continuously at each observatory. Considerable difficulty was experienced at Honolulu in April because of the excessive moisture in the seismograph house, and it became necessary to tear up the floor in order to remove the water which had accumulated underneath.

APPROPRIATIONS AND DISBURSEMENTS.

The appropriation made by Congress for the United States Coast and Geodetic Survey in the sundry civil act for the fiscal year ended June 30, 1918, was \$1,379,970, divided as follows:

Field expenses	\$487, 600
Repairs and maintenance of vessels	56, 000
Officers and men, vessels	320, 000
Pay of field officers	223, 500
Pay of office force	220, 770
Office expenses	67, 500
Offset attachment for lithographic press	3, 000
Paper-cutting machine	1, 600
Total	1, 379, 970

For the fiscal year ending June 30, 1919, the total amount appropriated is \$1,367,960, and the items of appropriation are as follows:

Field expenses	\$382, 600
Repairs and maintenance of vessels	38, 000
Officers and men, vessels	225, 000
Pay of field officers	223, 500
Pay of office force	253, 880
Office expenses	80, 000
Offset attachment for lithographic press (reappropriated)	3, 000
Two motor-driven lathes, at \$750	1, 500
One new vessel to cost \$354,000	50, 000
One new motor vessel	50, 000
Four or more new launches	62, 500
Total	1, 367, 960

DETAILS OF FIELD OPERATIONS.

HYDROGRAPHIC AND TOPOGRAPHIC WORK, ATLANTIC COAST.

MAINE AND NEW HAMPSHIRE.

[J. H. PETERS.]

SUMMARY OF RESULTS.—Hydrography: 83 square miles of area dragged, 149.3 miles run while dragging, 168 soundings retained.

Wire-drag party No. 1 was organized at Portsmouth, N. H., in April, 1917, for wire-drag work in Portsmouth Harbor and in the area between the entrance of the harbor and the Isles of Shoals, coast of Maine; continued work after July 1 with headquarters at Kittery Point. A subparty was engaged in tidal and current work in the same vicinity. Work was closed September 27, the party disbanded, and the records sent to the office.

MAINE, RHODE ISLAND, CONNECTICUT, AND NEW YORK.

[J. H. HAWLEY.]

SUMMARY OF RESULTS.—Triangulation: 18 square miles of area covered, 9 signal poles erected, 7 stations in supplemental schemes occupied for horizontal measures, 8 geographic positions determined. Levelling: 7 miles of levels run, 9 permanent bench marks established. Hydrography: 7.5 square miles of area covered, 41 miles run while sounding, 946 positions determined (double angles), 394 soundings made. Hydrography (wire-drag work): 27.4 miles of area dragged, 858 miles run while dragging, 10 retained soundings taken, 4 tide stations established, 3 current stations established, 4 hydrographic sheets (unfinished), scales 1:10,000 and 1:20,000.

Preparations were begun in March, 1918, for wire-drag work in Long Island Sound. A party was organized at Wickford, R. I., on April 15, and launches were chartered and equipped.

Immediately after outfitting at Wickford, R. I., wide-drag party No. 2 proceeded to Port Jefferson, N. Y., in order to take up the survey of the trial course

off that port in conformity with instructions dated April 13, 1918. The party arrived at Port Jefferson at 5 p. m. on April 25, 1918, and field work was begun on April 26.

It was found that the two buoys mentioned in the data furnished with the instructions as marking the approximate ends of the trial course were not in place, and current stations were accordingly located at about the points where these buoys would be placed, judging by the data furnished.

The main-current station was located at the western end of the course, and currents were observed at this station at hourly intervals for 52½ consecutive hours, beginning at 8.30 a. m. on April 26, 1918. For the greater part of this period the weather conditions were exceptionally favorable for current observations. During the daytime on April 26 and 27 simultaneous observations were obtained at a second station located near the eastern end of the course.

While current observations were being obtained, triangulation was carried on to locate the trial-course range beacons and prominent objects in the vicinity of the field of work. The beacons were found as described in the data furnished. The two westerly beacons have rectangular center poles about 4 by 10 inches in cross section. The easterly beacons have round center poles about 10 inches in diameter.

A tide gauge was established on the east breakwater at the entrance to Port Jefferson Harbor and connected with bench marks at Port Jefferson by levels. Hydrographic work was begun on April 30 and completed on May 2.

Wire-drag work was begun on May 3 and completed on May 6. As it is evident that submarines using this course must navigate waters westward of meridian $73^{\circ} 06'$, the western limit of the work requested by the Navy Department, the work was extended to meridian $73^{\circ} 07'$.

The work was somewhat delayed by smoke, haze, and fog, especially in the forenoons.

After completing the survey the party proceeded to Stonington, Conn., May 7, 1918, and at once began the wire-drag survey of the area in Long Island Sound, in the vicinity of Bartlett Reef Light Vessel.

This work was in progress on May 24, when instructions, dated May 23, 1918, to transfer the party to the coast of Maine were received. The equipment was loaded on the launches on May 25 and on May 26 the party left Stonington in the launches for the coast of Maine. It was necessary to stop at some harbor each night en route in order to secure accommodations for the party.

From June 3 until June 13 the party was engaged in signal building, triangulation, establishing a tidal station, and miscellaneous work. During this period the weather was mostly stormy, with fog and rain, and consequently unfavorable for wire-drag work.

Wire-drag work was started on June 14, and the survey was continued under very favorable weather conditions.

MAINE, NEW YORK, NEW JERSEY, PENNSYLVANIA, MARYLAND, AND FLORIDA.

[J. S. S. JONES.]

Between May 9 and June 22 an inspection was made of tide stations at the following places on the Atlantic coast: Portland, Me.; Fort Hamilton, N. Y.; Atlantic City, N. J.; Philadelphia, Pa.; Fort McHenry, Md.; Fernandina, St. Augustine, Key West, and Cedar Keys, Fla.

At each station the apparatus was overhauled, adjusted, and repaired when necessary, the gauges connected by spirit leveling with the bench marks, and new bench marks were established at some stations where the old ones had been destroyed.

MASSACHUSETTS.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Triangulation: 5 square miles of area covered, 16 signal poles erected, 1 station in supplemental scheme occupied for horizontal measures, 33 geographic positions determined. Hydrography: 8 square miles of area covered, 395 miles run while sounding, 3,058 positions determined (double angles), 24,833 soundings made, 4 hydrographic sheets finished, scales 1:5,000 and 1:10,000.

A supplementary survey of the approaches to the Cape Cod Canal in Buzzards Bay, Mass., was made between August 1 and September 28, 1917.

In this work the triangulation done by the Cape Cod Canal Co. was utilized and also the results of a survey made in 1917 by Corps of Engineers, United

States Army, covering a portion of the area to be examined. Points in the latter survey were connected with the work by the Coast and Geodetic Survey.

The triangulation for the control of the work and the connection with the triangulation of the United States Engineers and the Cape Cod Canal Co. was completed August 24, and the hydrography was taken up on September 4 and continued until September 28, when work was closed in this locality, and a survey was begun in the vicinity of Plymouth, Mass.

Between October 2 and November 15 a supplemental survey was made in Plymouth Harbor, Mass., to furnish additional lines of soundings required to complete the hydrographic surveys of that harbor, with the object of more clearly defining the sloughs through the mud flats. Sounding operations were begun October 15 and closed November 15.

RHODE ISLAND.

[F. B. T. SIEMS.]

SUMMARY OF RESULTS.—Triangulation: 4 stations in main schemes occupied for horizontal measures, 8 geographic positions determined. Wire-drag work: 14 square miles of area dragged, 50 miles run while dragging, 85 retained soundings, 1 wire-drag sheet partly finished, scale 1:20,000. Hydrography: 6 square miles of area covered, 50 miles run while sounding, 391 positions determined (double angles), 1,106 soundings made, 1 tide station occupied, 5 current stations occupied, 1 hydrographic sheet finished, scale 1:20,000.

Wire-drag party was organized in April, 1918, at Kittery Point, Me., by J. A. Daniels, pending the arrival of F. B. T. Siems, who took charge of the party on May 3. On May 4 the party and launches proceeded to the working grounds at Block Island, arriving there on May 6.

The launches accepted for charter by this party for wire-drag surveys, consisted of the *Gladys* as tender, the *Bernard F.* as end launch, and the *Wisdom*, which was building at the time of acceptance at Broad Channel, L. I., as guide launch. The *Wisdom* was intended to be delivered to the party on April 15, 1918. The launch, however, was still in an incomplete state by the latter part of June, when steps were taken to charter another launch to replace the *Wisdom*. The *Bernard F.* proved unserviceable for towing a wire-drag outfit over 3,000 feet in length, due to insufficient power; also, being of poor design, the launch rolled heavily in the seaway. Provisions for replacing the *Bernard F.* with a suitable launch were also made.

During May and June the *Lillian B.* was temporarily hired as a guide launch and was used with the *Bernard F.* for short wire-drag work off the west shore of Block Island.

Surveys requested by the Navy Department, consisting of a hydrographic and wire-drag survey of the 3-mile standardization course for submarines along the west shore of Block Island, extending from Sandy Point to Grace Point, were made during May and June. The hydrography covered an area five-eighths of a mile on either side of the trial course and extending about 5 statute miles in the direction of the trial course. The area swept by the wire drag, extends westward from the 10-foot curve along the west shore of Block Island between Sandy Point and Southwest Point to a junction with the wire-drag work previously completed south of Grace Point and about 2½ miles offshore north of Grace Point. Currents were observed at five stations on the trial course, the analyses of which show that the currents at these points are irregular, of small velocity, and influenced appreciably by winds.

The important bowlders and obstructions found by the wire drag are located within 1 mile of the shore. A wreck with 51 feet of water over it was found in a depth of about 75 feet, a 9-foot bowlder was found in a depth of 18 feet about one fourth mile offshore, and a bowlder with 15 feet of water over it was found three-eighths of a mile offshore near Southwest Point, the general depth here being 30 feet.

The ranges ashore marking 1 nautical mile distances on the trial course were located by triangulation.

[R. P. STROUGH.]

SUMMARY OF RESULTS.—Triangulation: 2 single poles erected, 4 stations in main scheme occupied for horizontal measures, 12 geographic positions determined. Leveling: 4 permanent bench marks established, 0.5 mile of levels run. Topography: 41.3 square miles of area surveyed, 41.3 miles of shore line of rivers surveyed, 2 miles of creeks surveyed, 21 miles of ponds surveyed, 55.6 miles of roads surveyed, 3 topographic sheets finished, and

1:10,000. Hydrography (wire drags): 139.7 square miles of area dragged, 217.1 miles run while dragging, 85 soundings made on shoals, 1 tidal station established, 2 hydrographic sheets finished. Hydrography: 6 square miles of area covered, 146.9 miles run while sounding, 1,012 positions determined (double angles), 5,541 soundings made, 1 tide station established, 1 hydrographic sheet finished, scale 1:10,000.

At the beginning of the fiscal year wire-drag work was in progress in Block Island Sound in the approaches to Narragansett Bay, R. I. Progress made in this work prior to July 1 is stated in the annual report for 1917.

On Sunday, July 1, the chief of party, with one launch, proceeded to Cerebus Shoal, Block Island Sound, and located the position of the U. S. S. *Olympia* and the buoys marking the shoal.

On July 23 assistance was rendered to the 98-ton, two-masted schooner *Emma F. Potter*, of Annapolis, Nova Scotia, which had gone ashore in a fog on the east bank of Sakonnet River about one-half mile north of Sakonnet, R. I. Some difficulty was experienced in finding the vessel in the fog, but she was finally located, and with the *Pilot*, one of the wire-drag launches used by the party, was towed off the shore and into Sakonnet Harbor.

On August 23 the party was visited by Lieut. Commander Frank Stewart, of the Argentine Navy, naval attaché to the Argentine Embassy, for the purpose of observing the operation of the wire drag.

The field work which could be economically carried on from Sakonnet was completed early in September, and on September 6 the headquarters of the party were moved to Saunderstown, R. I., on the shore of the west passage of Narragansett Bay.

On November 9 Commander Julio Dittborn, of the Chilean Navy, naval attaché to the Chilean Embassy, visited the party, and was given the opportunity to witness the drag in operation.

Supplemental instructions were issued September 19, October 3, and November 10 for wire-drag work between Bartlett Reef and the vicinity of The Race, Long Island Sound entrance, and this work, with the exception of a small area near Vallant Rock, was completed before the close of the season. On November 27 wire-drag work was discontinued in the vicinity of The Race, and the party returned to Saunderstown, R. I., where, on December 4, the party was discharged.

A scheme of triangulation was carried up Sakonnet River for the control of the hydrography and topography from two old recovered stations, Telegraph 2 and East Rock, and was connected with the old station, Anthony's Rock, at the entrance to Mount Hope Bay. This scheme included 14 occupied stations and 36 intersection stations, which were used for control of the hydrography and topography.

The entire shore line of both banks of Sakonnet River was traversed with the plane table.

A complete new hydrographic survey of the river was made and plotted on two sheets on a scale of 1:10,000. Lines were run at intervals of about 200 meters, and the shoal area, were closely developed.

In the operations from Sakonnet considerable delay was experienced at the beginning of the season in getting the drag work well underway on account of the prevailing southwest winds and the foggy weather. At the east end the work was joined to that done by J. H. Hawley in 1914 and was carried offshore south from Browns Ledge to the 20-fathom curve. Few shoals were found with less depths than 60 feet. Owing to the great depth to which the drag was set, the wooden floats with which the party was equipped water-logged very rapidly, and it soon became evident that metal floats were essential for this deep work. After July 1 metal floats similar to those used in Alaska were constructed and used during the remainder of the season.

In all an area of 145 square miles was dragged, using Sakonnet as a base, and in this area more than 50 shoals were discovered. The highest pinnacle found with the drag was a small rock about 15 feet in diameter at the top with 36 feet of water over it and surrounded by a depth of 72 feet. It was only after considerable search that the leadsmen succeeded in getting the sounding.

After changing the headquarters of the party to Saunderstown the drag work was carried on from that base, joining that which had been done from Sakonnet.

When the weather conditions would not permit of dragging in this area, work was done in the protected waters of the west passage of Narragansett Bay and Newport Entrance, but neither was completed. All the inside work was done with a short drag set very close to the bottom. An area of about 45 square

miles was dragged, using Saunderstown as a base, and in this area about 16 shoals were found, the most important of these being the 28-foot spot south of Brenton Reef buoy and the 31-foot spot at the entrance to the west passage.

Due to the strong currents and the great depth to which the area in the vicinity of Bartlett Reef and The Race was dragged, many difficulties were encountered which materially retarded the progress of the work.

The ordinary routine with the drag aground, which consists of sounding at the indicated location until a depth less than that at which the drag is set is found, was impracticable in The Race. In this strong current the entire drag, large and small buoys and all, was swept under and out of sight as soon as it touched bottom, and unless the tender was near the shoal when this happened there was no indicated location, and all efforts to find the shoal were fruitless. The proceeding in this case was immediately to begin to take up the drag and to endeavor to locate the shoal when the wire was seen to be caught on the shoal. This procedure was often prevented by the breaking of the wire.

Around shoal spots the strong currents caused whirlpools, by which the drag was drawn beneath the surface so as to catch at a depth below that at which the drag was set.

In all, in this locality an area of about 18.5 square statute miles was completed and about 21 shoals were found, the most important shoal being the 38-foot spot which lies about one-half mile west-southwest from Bartlett Reef Light Vessel, where the chart showed a depth of 14 to 20 fathoms. This region is a treacherous one on account of the numerous boulders and ledges.

A plane table survey was made of the street system of Jamestown, R. I., and the roads on Conanicut Island. The control for this work was obtained from the existing triangulation. In this survey a new determination was made of the position of the Jamestown standpipe.

A total of 32.5 statute miles of public roads was mapped, and brief notes as to the construction and condition of the roads were prepared.

The hired launches, *Pilot*, *Standard*, and *Edna M.*, were used in this work. These boats were the best that could be obtained, but they were not well suited to the purpose of a wire-drag survey.

The entire season's work was done at the request of the Navy Department.

RHODE ISLAND, CONNECTICUT, AND NEW YORK.

[P. M. TRUEBLOOD, July 1 to Sept. 28, 1917; H. P. RITTER, Sept. 29, to Nov. 6, 1917.]

SUMMARY OF RESULTS.—Physical hydrography: 40 current stations occupied, 18 tidal stations occupied.

The current and tidal survey of Long Island Sound, begun in May, 1917, was in progress on July 1 and was continued by the same chief of party until September 29, when he was relieved by Homer P. Ritter. Field was closed November 5. Two hired launches were used in this work.

Current stations were occupied at selected points in Long Island Sound and tributaries between New Haven and The Race and including Fishers Island Sound.

Automatic tide gauges were in operation at New London from the beginning of the season until November 3, at New Haven until October 2, and at New Suffolk, N. Y., from October 6 to 26.

Temporary tide stations were occupied at Herod Point, Long Island, Milford, New London, Clinton, Guilford, Cornfield Point, Orient Shoal, New Suffolk, Jamesport, Sag Harbor, Southold, Greenport, Niantic, and Two Tree Island Channel.

NEW YORK.

[I. M. DAILY.]

SUMMARY OF RESULTS.—Triangulation: 11 stations occupied for horizontal measures. Topography: 34 miles of shore line surveyed, 27½ miles of railroads and other roads surveyed.

Field work was begun July 21, 1917, on the revision of the triangulation and topography on the south side of Long Island Sound between Eatons Neck and longitude 73° 13' and from Matinicock Point around Hempstead Harbor to Sands Point.

Work was closed for the season on September 24, 1917.

[ISAAC WINSTON.]

Inspection duty for the region between Narragansett and Delaware Bays was continued by an officer who is in charge of a field station of the Survey, with an office in the Customhouse, New York City.

The demand upon the field station for nautical information and publications has greatly increased and its usefulness has been extended.

Copies of tide tables for 1918 and tables giving the time of sunrise and sunset and moonrise and moonset were prepared and furnished to persons desiring to publish them in local calendars, and in some instances the proof of these was read for the publishers. Similar tables were furnished to a number of newspapers and journals.

The inspector had charge of the Bureau exhibit at the Southern Commercial Congress held in New York October 15 to 17, and of an exhibit illustrative of the work of the Survey at the National Motor Boat Show, New York, January 19 to 26.

A triangulation station at the eastern end of Long Island was transferred to a new position, the change having become necessary on account of building operations.

The tide stations at Sandy Hook, N. J., Fort Hamilton, N. Y., and St. George, Staten Island, N. Y., were inspected in company with an officer of the Corps of Engineers, United States Army.

The inspector has voluntarily given one evening in each week to teaching nautical astronomy in the Hudson River Power Squadron Free School at the High School of Commerce and has distributed a number of canceled charts and tide tables, for purposes of instruction only, in these classes and also to the Naval School at Pelham Bay Park.

Attention was given to the inspection and shipment of material and supplies intended for the use of field parties of the Survey.

In May the inspector was engaged in certain field work on the coast of New Jersey, which had been requested by the Navy Department.

Information and publications were furnished to various officials and a stock of charts and nautical publications was maintained for reference, distribution, and sale to the public.

The privilege of obtaining charts and publications of the Survey from the field station without delay as emergencies arise is appreciated by officers of the Army and Navy, who have frequently expressed their gratification at the convenience.

The inspector was called upon to testify as a witness in court on two occasions where expert testimony was required on questions relating to surveys.

VIRGINIA.

[PAUL C. WHITNEY, Commanding Steamer *Bache*.]

SUMMARY OF RESULTS.—Triangulation: 5 square miles of area covered, 6 stations occupied for horizontal measures, 24 geographic positions determined. Topography: 1 square mile of area surveyed, 5.5 miles of shore line surveyed, 3 miles of creeks and sloughs surveyed, 4 miles of roads surveyed, 3 miles of railroads surveyed. Hydrography: 3 square miles of area surveyed, 258 miles run while sounding, 2,821 positions determined (double angles), 23,000 soundings made, 1 tidal station established, 3 tidal bench marks established.

On July 1 the steamer *Bache* was lying at Norfolk, Va., preparing for field work, repairing and outfitting. Office work in connection with the previous field season was in progress during the month of July.

During the latter part of the month a request was made by the naval authorities at Norfolk and confirmed by the Navy Department at Washington, D. C., for a detailed topographic and hydrographic survey of Sewall Point and vicinity, at which locality extensive improvements were to be made in connection with the new naval operating base.

This survey was required on account of large improvements along the water front. The plans were for building some 18,000 feet of bulkhead, reclaiming about 350 acres, and dredging 7,000,000 cubic yards of material. To obtain the necessary data to compute the yardage moved and to locate the bulkhead and piers a close hydrographic survey was needed, together with the establishment of numerous triangulation points.

This work was started during the last few days of July and was practically completed at the time the vessel was transferred to the Navy.

A triangulation scheme was observed resting on Newport News Middle Ground Light and Old Point Comfort Light as a base. This scheme served to

cut in all the hydrographic signals as well as objects located on the topographic sheet. An azimuth was observed to verify the triangulation.

The hydrography was executed on a scale of 1:5,000. Sounding lines were run on located ranges at distances approximately 100 feet apart. It was essential that these lines be run as nearly straight and parallel as possible, and great care was exercised to meet these conditions.

A tide staff was established along the north shore of Sewall Point in the small lagoon. This staff was connected with the United States Army Engineers' bench mark on the Virginian Railway's pier.

A topographic survey was made on a scale of 1:5,000 and showed the shore line and the old culture and improvements of the base at the time the survey was being carried out, but since the survey this area has been so improved that the topographic features have been entirely changed.

In connection with the development of the naval base the results of the triangulation, topography, and hydrography from this survey were used constantly and were a great aid in laying out the extensive water-front improvements and in the proper orientation of the streets and building lines.

In conformity with an Executive order dated September 24, 1918, the steamer *Bache*, with the complement, supplies, and equipment, was transferred to the Navy Department on that date and the commanding officer reported to the commandant of the Norfolk Navy Yard.

[E. B. LATHAM, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Triangulation: 4 square miles of area covered, 9 signal poles erected, 5 stations in main scheme occupied for horizontal measures, 7 geographic positions determined. Hydrography: 25.5 square miles of area covered, 205 miles run while sounding, 1,864 positions determined (double angles), 9,891 soundings made, 1 tide station established, 1 current station occupied, 3 hydrographic sheets finished, scales of hydrographic sheets 1:20,000 and 1:10,000. Levelling: 3 miles of levels run, 2 permanent bench marks established.

On February 8, 1918, when the command of the *Matchless* was transferred, the vessel was undergoing general repairs at Norfolk, Va. These repairs were completed March 14. The work of outfitting the ship, taking stores on board, and securing a crew occupied the time until May 3, when the *Matchless* left Old Point Comfort for Westpoint, Va., arriving May 5. The hydrographic work required at Westpoint was completed May 25, and the vessel then sailed for Gloucester Point. Work in that vicinity was taken up on arrival May 28, and was in progress at the close of the fiscal year.

Under instructions issued in December an officer was sent to Columbia, N. C., to investigate the existence of a number of sunken logs obstructing navigation in the Scuppernon River. A special report was made on this subject.

At the request of the Navy Department surveys were made to determine the depths around the coal piers at Newport News and a 29-foot spot which had been reported in the dredged channel in Hampton Roads leading to Newport News. These surveys were completed between April 15 and 30, and copies of the results were furnished to local naval authorities.

As directed in supplemental instructions, a hydrographic investigation was made of the York and Mattaponi Rivers near Westpoint, Va., and in the Mattaponi River from deep water in York River to the shipyard of the York River Ship Building Corporation. Old triangulation stations were recovered, and several objects and signals were determined by triangulation.

This survey was done to enable the York River Ship Building Corporation to take vessels under construction for the United States Shipping Board from the Mattaponi River to deep water in the York River, and to determine what dredging was needed to effect that end. Advance information of the results of this work was furnished the York River Ship Building Corporation.

The hydrographic survey of York River from Gum Point to York Spit Light, made at the request of the Navy Department, and of the inshore area from York Spit Light to a junction with recently completed work south of Thimble Shoal Light, was begun May 28 and was in progress at the close of the fiscal year.

The location of signals and objects requested by the naval authorities was given precedence over other work. The signals below Gloucester Point were erected by the naval authorities and determined by the party on the *Matchless*. Above Gloucester Point the signals were erected and determined by the Coast and Geodetic Survey party, and the hydrography was begun. Lines of soundings 400 meters apart run at an angle of approximately 45 degrees with the

channel were completed below Pages Rock Light, and signals were erected and determined to carry the work to The Marshes Light.

[HARRY LEYPOLDT, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Hydrography: 85 miles run while sounding, 970 soundings made, 1 tide station occupied.

On June 25, 1918, the party on the steamer *Hydrographer* began a survey of the lower part of Chesapeake Bay. Signals were built, two tide gauges were erected, and the work was in progress at the close of the fiscal year.

NORTH CAROLINA.

[N. H. HECK, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Triangulation: 2 stations occupied for horizontal measures. Topography: 15 miles of shore line surveyed, 24 miles of roads and railroads surveyed. Hydrography: 56.5 miles of area covered, 379.2 miles run while sounding, 13,121 soundings made, 2 tide stations established.

On July 1, 1917, the schooner *Matchless* was engaged in the hydrography of Pamlico Sound, N. C., and most of the preliminary work of signal building and triangulation had been completed.

During July the hydrography and topography were actively carried on. The hydrography was of three classes: Offshore, that is at a distance from the low-lying islands on the eastern side of the sound; shoal water, in depths from 2 to 10 feet, the aim of which work was to develop sloughs or narrow channels through the shoals; and over flats with less than 2 feet of water, where depths were obtained by wading.

All of the work was retarded in the early part of July by the failure of the launches. The progress of the work was found to depend largely upon the use of suitable launches.

As the result of recommendations made at that time a new motor sailing launch was ordered and an excellent 32-foot, flat-bottomed launch was leased. An observing platform was constructed on the latter launch for the purpose of bringing the eye of the observer high enough for the offshore work. Other boats of the vessel were used as signals for the work farthest from land.

On July 25 the charge of the party was transferred to R. F. Luce.

[R. F. LUCE, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Topography: 7.5 square miles of area surveyed, 12 miles of shore line surveyed, 16 miles of roads and railroads surveyed. Hydrography: 183 square miles of area covered, 546 miles run while sounding, 20,670 soundings made, 5 tide stations occupied.

During August and September the party on the schooner *Matchless* was engaged on the survey of Pamlico Sound, as elsewhere mentioned in this report. The survey was in progress at the close of September. The continuation of this work is reported in another abstract.

[E. E. SMITH, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Triangulation: 4 stations occupied for horizontal measures. Topography: 15 square miles of area surveyed, 44 miles of shore line surveyed. Hydrography: 94 square miles of area covered, 600.9 miles run while sounding, 23,546 soundings made, 2 tide stations established.

During the month of October the survey of Pamlico Sound was continued. The headquarters of the vessel was at Manteo, N. C.

The command of the *Matchless* was transferred to E. E. Smith on October 18.

The instructions under which the party was operating had in view the continuation of the work in Pamlico Sound to a junction with the completed work at the south end of Roanoke and Croatan Sounds.

By instructions issued November 19 the completion of the hydrographic survey of Pamlico Sound from Long Shoal to Croatan and Roanoke Sounds was postponed, and the party was directed to complete the topography of the ocean shore line of the outer beach from New Inlet to Oregon Inlet, to complete certain additional work in Croatan Sound, and then to discontinue work in Pamlico Sound and vicinity and proceed with the *Matchless* to Elizabeth City, N. C., for repairs.

Surveys in Croatan and Roanoke Sounds were completed on December 27. Then followed a series of gales with snow and freezing weather, and the vessel

was held in the ice until January 17, when the ice was broken up and the schooner was towed to Elizabeth City, N. C. After much delay in securing a tug, vessel left Elizabeth City on the 29th, and was taken to Norfolk, Va., the same day for repairs.

On February 8, E. B. Latham relieved E. E. Smith of the command of the *Matchless*.

FLORIDA.

[J. H. HAWLEY.]

SUMMARY OF RESULTS.—Hydrography (wire drag): 140 square miles of area dragged, 231.1 miles run while dragging, 1,121 positions determined (double angles), 10 soundings taken (on shoals), 520 supplemental soundings made, 1 hydrographic sheet completed, scale, 1:40,000.

Wire-drag work in the vicinity of the westerly Florida reefs was in progress at the beginning of the fiscal year. Fort Jefferson, on Dry Tortugas, was used as the base of operations throughout the season.

Whenever weather conditions permitted, work was done in the vicinity and southward of Rebecca Shoal until the easterly limit of the work was from 15 to 18 nautical miles distant from Dry Tortugas. Because of the slow speed of the launches used by the party it was found impracticable to extend the work beyond this limit.

The southern limit of the work was then extended well beyond the line of shoal soundings shown on the chart, and the work southward and eastward of Dry Tortugas was continued to a junction with the work in Rebecca Shoal Channel. This resulted in the completion of a continuous area extending from Rebecca Shoal to Dry Tortugas and southward to the general locality of the 20-fathom curve.

Eighteen shoals were found in this area, all but one being in the vicinity of Rebecca Shoal.

To supplement the hydrographic data in this region, soundings were obtained during the course of dragging operations from the large tender. While the drag was underway the tender ran back and forth across the drag, and soundings were obtained at certain drag buoys as directed. Each sounding was recorded, together with the time and buoy at which it was taken, so that all soundings could be plotted on a tracing of the smooth drag sheet. About 800 soundings were obtained in this manner.

A tide staff was maintained at Garden Key during the season and tidal bench marks were recovered and established on the Key.

From one-half hour to one hour's time was saved each day on the runs to and from the working grounds by the discovery and use of a 4-foot channel across the reefs opposite Port Jefferson.

On several days in September the wire-drag launches and their crews were used by the naval authorities at Dry Tortugas.

The weather conditions during the season were generally favorable. This was an important factor affecting the work in Rebecca Shoal Channel. It required from five to six hours per day to run to and from the working grounds, and good weather throughout the entire day was essential for the successful prosecution of this work.

The chartered launches *Twilight*, *Standard*, and *Starlight* were used in this work. While they were the best boats available, they were not well suited for the work.

Four floating signals made up of navigational buoys with superstructures were used in this work, and gave satisfactory service. A 60-foot hydrographic signal was erected on East Key and located by triangulation.

To carry the work beyond the limit of visibility of these signals, a special type of floating signal was devised and constructed by the party.

This signal was easily handled and found to be of ample size for the work, and during the latter part of the season was used in preference to the larger buoy signal with satisfactory results. They were securely anchored and located by sextant angles observed at the signal.

The semaphore signaling machine constructed in 1916 was used during the season with satisfactory results.

Work was closed for the season on September 29.

ALABAMA.

[HARRY LEYPOLDT, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Hydrography: 175 square miles of area covered, 891 miles run while sounding, 3,118 positions determined (double angles), 32,437 soundings made.

On April 22, 1918, the command of the steamer *Hydrographer* was transferred by F. B. T. Siems to Harry Leypoldt. The ship was then at Mobile, Ala., completing repairs. The topographic survey of upper Mobile Bay was in progress at the time.

On April 25 the *Hydrographer* and hired launch *Acacia* left for the working grounds and hydrographic work was resumed. On the following day it became necessary to return to Mobile for further repairs to the engine.

On April 30 a two weeks' series of current observations was begun abreast Fort Morgan. High winds prevailed for three days, greatly influencing the currents. When the wind and sea subsided hydrography was begun in the entrance and carried westward to a junction with previous work near the western end of Dauphin Island. The topography of the southern shore of Dauphin Island was also completed.

When current observations were completed the ship commenced signal building and hydrography of the outer coast from Mobile Bay entrance to the eastern limit of the topographic sheet.

There was no triangulation control for this region, so resort was had to a plane table traverse from Fort Morgan to triangulation station ALA, at the western side of Perdido Bay. This station had been destroyed, but a reference mark (blazed tree) was recovered. The traverse checked remarkably well, there being an error of about 25 meters in distance. The ship or launch parties kept ahead of the topographer with signals and then commenced sounding without a boat sheet, the signals being as yet undetermined. The lines were fairly straight and evenly spaced. The instructions called for hydrography to the 6-fathom curve, but in places this was close to the beach, with shoaler water offshore, so that an irregular system of lines finally resulted, as some of the earlier lines did not go offshore far enough to go beyond the outer 6-fathom curve.

The shoals at the eastern side of the Mobile Bay entrance channel were well developed and they appear to have undergone little change. Those to the westward apparently shift with every storm, and the islands as charted have been washed away to a large extent, so that only a few small sand keys remain, with shoal water between them.

On May 23 the outer hydrography and topography were completed, and the unfinished work remaining was the topography of Bon Secours Bay and a few small stretches in the vicinity of the rivers at the head of Mobile Bay.

The launch *Acacia* had during this time completed the hydrography of Bon Secours Bay and part of the topography of this bay, together with several areas of hydrography near the head of the bay.

From May 25 to May 28 the ship was being made ready for the trip to Chesapeake Bay, while the *Acacia* finished the work at the head of Mobile Bay.

On May 29 the shore party was disbanded, and at 6 p. m. the *Hydrographer* cast off and sailed for Key West, Fla., arriving there in the late afternoon on June 1 after an uneventful trip, having made a landfall at Tampa.

On June 3 the *Hydrographer* sailed from Tampa for Norfolk, Va., stopping at Savannah, Charleston, and Beaufort. The vessel arrived at Norfolk June 14.

LOUISIANA AND MISSISSIPPI.

[H. A. SERAN, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Topography: 98 miles of general coast line run, 2 topographic sheets finished, scale 1:40,000. Hydrography: 575 square miles of area covered, 1,075 miles run while sounding, 30,159 soundings made, 3 tide stations established, 2 hydrographic sheets finished, scale 1:40,000. Leveling: 2 miles of levels run, 3 permanent bench marks established.

On July 1, 1917, the steamer was temporarily laid up at New Orleans on account of lack of funds. On July 2 instructions were received and an allotment made, and on July 7 the vessel left New Orleans to continue work in Mississippi Sound from Gulfport as headquarters. A shore party was established at Pascagoula on July 16, and continued the work begun at this point in May, 1917.

The hydrography of Mississippi Sound was extended from the eastern limit reached at the end of June eastward to the limits of hydrographic sheet C, north of Ship Island. The hydrography between Ship Island and Chandeleur Islands was completed, except for a small portion lying immediately east of Chandeleur Islands.

The shore party working from Pascagoula extended the hydrography from a line connection, Belle Fontaine Point, and the west end of Horn Island eastward to a line connecting the western shore of the bay immediately west of Grand Bay and a point due south of this shore on Petit Bois Island. No hydrography outside of Horn or Petit Islands was done.

The topography was extended from Belle Fontaine Point to the western shore of the bay lying immediately west of Grand Bay on the north shore, and also the topography was completed of Horn Island, Petit Bois Island, Round Island, Ship Island, and that portion of Chandeleur Islands within the limits of hydrographic sheet C.

An automatic tide gauge was continued in operation at St. Louis Bay, and tide-staff readings were taken at Pascagoula and the quarantine station at Ship Island.

Records were also obtained from the automatic tide gauge maintained by the Mississippi River Commission at Biloxi, Miss.

Some additional offshore work was done east of South Pass, Mississippi River. Shoal soundings had been reported in this vicinity, but nothing was found to justify such reports.

The command of the vessel was transferred to F. B. T. Siems on September 16, 1917.

[F. B. T. SIEMS, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Triangulation: 182 square miles of area covered, 13 signal poles erected, 1 water signal erected, 16 stations in supplemented schemes occupied for horizontal measures, 52 geographic positions determined. Levelling: 3 miles of levels run, 15 permanent bench marks established. Topography: 140 square miles of area surveyed, 298 miles of general coast line surveyed, 162 miles of roads surveyed, 2 topographic sheets finished, scales 1:40,000 and 1:10,000. Hydrography: 950 square miles of area sounded, 2,918 miles run while sounding, 8,864 positions determined (double angles), 111,438 soundings made, 9 tide stations established, 5 current stations occupied, 3 hydrographic sheets finished, scale 1:40,000.

This report covers the period from September 16, 1917, to April 21, 1918, while the steamer *Hydrographer* was in command of F. B. T. Siems.

The central part of Mississippi Sound, the inlets between Ship Island and Horn Island, together with the adjoining gulf coast, and the hydrography of the gulf coast southward of Horn Island were surveyed by the party of the steamer *Hydrographer* from September 18 to October 11, 1917. A small area of hydrography northeast of Chandeleur Islands was also completed during this period.

The weather during September and October was generally fair, and enabled the party to work outside of Ship Island, Horn Island, and Dog Key and develop the passages between these islands under very favorable circumstances. A hurricane, the center of which traversed the working grounds during the latter part of September, blew down several signals which had to be rebuilt later and the storm itself caused a suspension of field work for three days.

The *Hydrographer* called at Gulfport, Miss., for coal, mail, and supplies while operating in the central part of Mississippi Sound, and after the completion of this work on October 12 the ship proceeded to Mobile, Ala., which was used as a base for operations in eastern Mississippi Sound and Mobile Bay.

About the middle of October the surveys in the eastern end of Mississippi Sound were taken up by the ship's party. Some time was necessary to recover old triangulation stations, build signals, and perform additional triangulation for determining the positions of supplementary stations and the aids to navigation marking the dredged cut through Pass aux Heron. Topographic work was begun at Cedar Point and on Dauphin Island, and was extended westward to form a junction with the completed topography. At the same time hydrographic work was begun in Pass aux Heron Channel and surrounding locality and then extended westward. A tide station was established at Beacon & Pass aux Heron, for the hydrography in that locality. Currents were observed at the west end of the pass for 72 consecutive hours and again for 42 consecutive hours.

Combined operations in the eastern part of Mississippi Sound between Horn Island Pass and Pass aux Heron were continued during November and December, 1917, and during part of January, 1918, and included the hydrographic

development of the new Inlet between Petit Bois Island and Dauphin Island, Horn Island Pass, and the hydrography of the adjoining Gulf coast out to the 6-fathom curve. Continuous hazy and stormy weather during the winter months retarded the progress of the surveys considerably; also the field work was delayed on account of boiler trouble. The progress of the topography was slow on account of the intricate and muddy marsh areas, which make up the greater part of the north shore of Mississippi Sound. Considerable time was spent in strengthening the marking of the numerous triangulation stations in this locality, while other field work was impossible. Tides were observed at Bayou la Batre, Horn Island Pass light, and the west end of Dauphin Island.

A shore party equipped with a chartered launch and composed of four officers and eight hands, under the direction of the commanding officer of the steamer *Hydrographer*, executed certain portions of the survey of Mississippi Sound, Lake Borgne, and Mobile Bay. At the beginning of the period covered by this report the shore party continued operations in Mississippi Sound near Pascagoula, at which town the party was quartered. Horn Island Pass, the channel paralleling Horn Island, and the surrounding shoals were developed by this party during September and October. On October 21 the shore party was transferred to Bayou la Batre to assist the ship's party in the surveys of the eastern part of the sound.

During the latter part of December the shore party was transferred to Bay St. Louis for surveys in the western part of Mississippi Sound and in Lake Borgne, covered by the Superintendent's supplemental instructions of November 30, 1917. Two new launches were chartered for this work and two additional hands were employed in the party. These surveys included the topography from Isle au Pitre to Point aux Marchettes, the hydrography northward of these shores and extending to the previously completed hydrography of the fiscal year 1917, and the redevelopment of Pass Christian and Pass Marianne Channels. On account of the exposed locality, with the prevailing north winds occurring at that time of the year, the progress of this work was necessarily slow. Sufficient triangulation stations were recovered for the necessary control of the detailed surveys. Tides were observed at Malheureux Point and at Bay St. Louis. During January, February, and part of March, 1918, the shore party was engaged in the surveys outlined above.

The survey of Mississippi Sound (with the exception of its western portion not then completed by the shore party) and the adjoining Gulf coast to the 6-fathom curve, was completed early in January, 1918. The *Hydrographer* then took up the survey of Mobile Bay, under the Superintendent's instructions dated December 8, 1917.

The numerous channel beacons in Mobile Bay were readily located by triangulation from recovered United States Army Engineer triangulation stations. These beacons served as excellent hydrographic signals for the greater part of Mobile Bay, and were also very useful for the control of the topography. Considerable progress was made in the hydrography of the bay by the ship during the latter half of January. The combined operations in the central part of Mobile Bay were undertaken at that time, the plan being to leave the work at the head of the bay for the time while the ship would be repairing at Mobile during April, and the entrance and Gulf coast during the favorable weather conditions which could be expected after the repairs had been completed.

During February field work in general was delayed by frequent fogs and rains. A short spell of good weather, however, enabled the party to execute the triangulation scheme of Bon Secours Bay. In order to avoid long lines of sight a central point figure was used by building a signal in 11 feet of water. This triangulation was extended from the line Mobile Bay Light-Fort Morgan. Natural objects, principally trees, and supplementary signals were located by triangulation for hydrographic signals and topographic control.

The topography of the east and west shores of Mobile Bay was progressing favorably while the ship was engaged in hydrography and triangulation in the proximity of the topographic party. Particular attention was given to the mapping of roads and settlements located not more than 1 mile inland.

The *Hydrographer* was at Mobile, Ala., from March 7 to 9 for inspection by prospective bidders for repairs to the vessel. The contract for the repairs, consisting principally of the installation of a new boiler, was awarded to the Alabama Dry Dock & Shipbuilding Co. on March 19, and the vessel was delivered to the contractors on the following day. Repairs by the contractors were completed on April 16. Considerable work of cleaning and painting the

ship and adjustments in the engine room were necessary, and the ship remained at Mobile until after the date of the transfer of the command to another officer on April 22, 1918.

While the ship was undergoing the repairs, field parties were engaged in combined operations at the head of Mobile Bay and in the vicinity of Mobile. The triangulation of Mobile Bay was extended by a central point figure for the control of the detailed surveys of the rivers at the head of the bay. Marked changes in the bars at the entrances of these rivers necessitated considerable development of these areas. The topography was made difficult by the tall marsh reeds and unstable ground. In most places a plane table could not be used, and it was necessary to resort to a sextant for topographic work. A detailed survey of the water front of Mobile was made on a 1:10,000 scale projection.

The shore party completed the surveys in the western part of Mississippi Sound and in Lake Borgne, and on March 14 proceeded to Mobile Bay for assignment to work in that locality. This party was engaged in observing currents and on inshore hydrography in the central portion of Mobile Bay and on combined operations at the head of the bay during the last two weeks of March and the first three weeks of April.

Automatic tide gauges were established at Fort Morgan and Mobile, and subsidiary tide staffs at Great Point Clear, Weeks Bay, and Alabama Port.

On April 22, the date of the transfer of the command of the steamer *Hydrographer* to another officer, the survey of the head of Mobile Bay, including Mobile, and of the greater portion of the bay itself was completed. The principal work remaining to be completed consisted of the hydrography and topography of the greater part of Bon Secours Bay, the development of the entrance of Mobile Bay, and the survey of the Gulf Coast.

LOUISIANA.

[J. B. BOUTELLE.]

A field station was opened at New Orleans, La., on February 27 with an office in room 503, Godchaux Building. Notice of the establishment of this office was published in local newspapers, and was brought directly to the attention of Government officials, shipping companies, and firms connected with maritime business.

Since the establishment of the office many requests for publications and information from the Army and Navy and other branches of the public service have been received and complied with. An inspection has been made of the agencies for the sale of publications of the Survey in New Orleans, and they have been supplied with charts from time to time, to meet requests for such as they had not in stock.

Monthly tide tables and tables of the time of sunrise and moonrise and sunset and moonset were supplied to the local newspapers for publication.

Information was supplied to the office of the Survey at Washington in regard to reported dangers to navigation, changes in shore line and depths, copies of recent surveys by the United States Engineers, descriptions of inland waterways, and other matters necessary for the correction of the charts, coast pilots, and tide tables.

TEXAS.

[J. B. BOUTELLE.]

During the first half of the fiscal year an officer was engaged on inspection duty for the coasts of Texas and Louisiana, with headquarters at Galveston, Tex.

Information in regard to surveys, geographic positions, elevations, tides, currents, changes in aids to navigation, etc., was furnished to the Coast and Geodetic Survey Office, to officials of the Government, and others applying therefor.

A stock of charts and nautical publications was maintained for distribution, reference, and sale.

From August 7 to 31 the inspector, at the request of the United States Engineers, executed a resurvey of Brazos Santiago Pass and Harbor to obtain data for estimates for improving that port by dredging a harbor and channel and building jetties.

HYDROGRAPHIC AND TOPOGRAPHIC WORK, PACIFIC COAST.

CALIFORNIA.

[E. F. DICKINS.]

An officer of the Survey has continued on duty as inspector of the Bureau for the coast of California and in charge of the field station at San Francisco, Cal.

The principal duty of the inspector in charge of the field station is the inspection of the navigable waters within his district, to assist in keeping the charts, coast pilots, and tide tables of the Survey corrected to date, and to furnish information relating to our coasts to the public.

Under the supervision of the inspector an automatic tide gauge was maintained throughout the year at the Presidio station, San Francisco, obtaining a continuous record of the time and height of the tide.

Arrangements were made by the inspector to install apparatus for current observations on the light vessels within his district, an authorization for which is contained in the sundry civil act for 1919.

The inspector has kept on hand a stock of charts and nautical publications for sale and reference. He has obtained information for the correction of the charts and coast pilots; furnished information in regard to surveys to Government officials and others applying therefor; has supplied tidal information and advance notices to mariners, to the public, and for publication in the newspapers; attended to forwarding instruments and supplies to the field station of the Survey at Manila; and furnished transportation to officers of the Survey upon request.

WASHINGTON.

[J. F. PRATT.]

An officer of the Survey has continued on duty as inspector of the Bureau for the coast of Alaska, Washington, and Oregon and in charge of the field station at Seattle, Wash.

This field station has continued to prove very helpful to the Alaska parties, to the public, and Government officials within the district, and to the Bureau at Washington in keeping it informed of the condition of the surveys on the western coast. Special consideration was given to surveys that are urgently needed in Puget Sound waters, and the revision of the survey of the Lake Washington Canal and Seattle waterways.

The field station cooperated with the United States Steamboat-Inspection Service by examining seamen for certification as lifeboat men.

Self-registering tide gauges were kept in operation at Seattle and Olympia. Information in regard to the tides was furnished for publication in the newspapers.

Designs and specifications were prepared for wire-drag apparatus for purchase for the field parties of the Bureau in Alaska.

Assistance was rendered in laying up the vessels of the Survey at Seattle in the fall of 1917, and the inspector was placed in charge and handled the accounts of all the vessels and parties at Seattle, the commanding officers and other chiefs of parties having been transferred to the Navy.

Arrangements were made to secure plans and specifications for a vessel to replace the *Taku*, provision for which is made in the sundry civil act for 1919.

The inspector furnished information and publications to Government officials applying therefor, and kept on hand a stock of charts and nautical publications for sale and reference. He attended to the enlistment of seamen, the purchase of supplies, and the forwarding of instruments and supplies to the parties of the Survey in Alaska and furnished transportation to officers passing through Seattle on their way to and from the field.

[JOHN A. DANIELS.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 2 miles, 5 points selected for scheme. Base lines: 1 secondary, 2,045.6 meters in length. Triangulation: 3 stations in main scheme occupied for horizontal measures, 49 geographic positions determined. Leveling: 1 mile of levels run, 7 permanent bench marks established. Topography: 14½ square miles of area surveyed, 30 miles of general coast line (river and canal) surveyed, 86½ miles of roads surveyed, 3 topographic sheets finished, scale 1:5,000. Hydrography: 8.75 square miles of area covered, 97 miles run while sounding, 2,094 positions determined (double angles), 4,645 soundings made, 3 tide stations established, 5 hydrographic sheets finished, scale 1:5,000.

Chart-revision work in the vicinity of Seattle, Wash., including triangulation, topography, and hydrography, was in progress at the beginning of the fiscal year.

This work was done in order to show changes due to the construction by the United States Army Engineers of the Lake Washington Ship Canal connecting Puget Sound and Lake Washington through Salmon Bay and Lake Union and the construction of a lock at the narrow part of Salmon Bay, the improvements making these waters a part of Seattle Harbor.

The completion of this project lowered the level of Lake Washington 8 feet and raised the level of Lake Union about 10 feet. The entire waterway from Lake Washington to the lock at the western end of Salmon Bay is now continuous, and the water level is controlled by gates at the dam alongside the lock.

A resurvey of Smith Cove was necessary because of the recent construction of a large terminal and dock.

In the southern part of Seattle the Duwamish Waterway Commission, in cooperation with the city of Seattle and King County, have straightened and deepened the Duwamish River from the head of the East and West Waterways for a distance southeastward of about 4 miles. The material dredged from the straightened river was used to fill the old river bed and other near-by depressions. Street and railroad facilities have been built along the eastern shore of the waterway, with the consequent addition of many shipyards and industrial plants.

Topographic revision in the vicinity of Alki Point and West Seattle was necessary to show the various improvements along the water front and also the addition and extension of several roads and streets that improve considerably the grades in the approaches to West Seattle.

The necessary triangulation consisted of a tertiary scheme from Salmon Bay to the southern end of the Duwamish Waterway, crossing Smith Cove and Elliott Bay, a distance of approximately 10 statute miles. A base line was measured along the eastern side of the Duwamish River upon a new paved roadway.

The connection between points in the vicinity of Salmon Bay with those in Smith Cove was begun by the party of the steamer *Patterson*, C. G. Quillian commanding. All of the seven signals necessary to reach Smith Cove without connecting to known points across Elliott Bay were built, one of the stations was completely occupied, and two partially observed by the *Patterson* party. In order to complete this connection with triangulation points recovered in Elliott Bay it was necessary to build 2 signals, occupy 7 complete stations, and partially observe 2 others. The complete scheme from Salmon Bay to South Park, Seattle, contains 23 main-scheme stations, of which 15 were occupied. There are 18 closed triangles, with an average closure of 2.1 seconds. The length of the scheme is about 10 statute miles, and its area 16 square statute miles.

Advantage was taken of an excellent opportunity to measure a secondary base along the newly built brick pavement situated on the eastern side of the new Duwamish Waterway. The pavement is level and straight, except for one slight bend for over a mile, and as yet very few buildings have been erected to obscure lines of sight. The base was completely measured forward and back in two sections in two forenoons.

When the work was taken over one or two days' work had been done upon the topographic sheet of Shilshole Bay. The topography of the water front and shore line of the new canal was completed through Union Bay to Lake Washington proper. The low land between Salmon Bay and Smith Cove was surveyed, together with the shore line and water front of Smith Cove. In the western and southern part of Seattle the shore line was run from 1 mile southward from Alki Point around Duwamish Head, including East and West Waterways and the new Duwamish Waterway to its head, about 4 statute miles from the junction of the East and West Waterways. The industrial section between the East Waterway and the high land to the eastward was concluded.

The topography was all done upon a scale of 1:5,000, and was included upon six sheets. Much care was taken throughout the work to avoid errors due to distortion of the sheets, and all details were accurately located. No elevations were determined or contours drawn, but new roads and streets, showing changes from the previous surveys, were run in. The greater part of the topography was done by Douglas Karr, junior hydrographic and geodetic engineer, with a

party of two rodmen. Street cars were used for transportation, except at a few inaccessible points, where a light auto truck was hired to carry the instruments and party. The weather conditions were very favorable for topography throughout the summer.

The hydrography was done upon five sheets upon a scale of 1:5,000. Two of the sheets include the Lake Washington Canal and adjacent waters, except Lake Washington; another taken in Smith Cove and vicinity; and the other two embrace the Duwamish River section. In general the sounding was done on lines 50 meters apart. The boats used were loaned to the party by the steamer *Explorer*. In the more open waters the steam launch was used, and in other localities the small whaleboat was more efficient. The commanding officer of the *Explorer* cooperated in the hydrographic work by furnishing boats and men.

Inshore sounding was done in Shilshole Bay and in the entire water area in and bordering the ship canal from the above bay to the cut between Portage Bay and Lake Washington. One day's work was done to locate definitely the entrance to the dredged channel of the canal from Lake Washington.

Large tows of logs were found moored along the banks of the canal all the way from the lock to Lake Union. The area covered by the logs was considerable, and was sounded out by walking over the rafts and dropping the lead between the logs. Lines about 60 meters apart were run throughout the work. In the southern part of Seattle the East and West Waterways were sounded with their approaches and the new Duwamish Waterway, with its accessible tributaries and slips, was developed to the southern limit of the dredging. In Smith Cove the approaches to the docks were carefully sounded out. The hydrography was done upon a scale of 1:5,000 and includes five sheets. The Lake Washington Canal, Smith Canal, and Smith Cove work was done under the immediate direction of the chief of party and the remainder was done by a party in charge of Henry Bernhardt, mate.

While work was in progress in Shilshole Bay outside of the lock, tides were observed upon a staff near the northwest abutment of the Great Northern Railroad bridge. Inside of the lock the lake levels were determined by the Army Engineers at the lock by readings taken twice each day. By obtaining copies of their records it was possible to reduce the soundings to mean lake level, the datum adopted by the Army Engineers and the United States Coast and Geodetic Survey for depths in the canal and the lakes. Two tidal stations were established upon the Duwamish River and readings taken on staffs while work was in progress. Comparisons with the values obtained from the automatic gauge maintained at Madison Street, Seattle, showed very little difference in time or range.

GEODETIC WORK.

NEW JERSEY.

[ISAAC WINSTON.]

SUMMARY OF RESULTS.—Triangulation: 40 square miles of area covered, 17 stations occupied for horizontal measures, 24 geographic positions determined.

In the latter part of April, 1918, after consultation with the naval authorities at Sandy Hook, N. J., the Coast Guard stations Long Branch, Deal Beach, Shark River, Spring Lake, and Squan Beach were visited in company with an engineer, who indicated the objects used as reference points in measuring angles to determine the positions of shells falling in the water in sight of the stations.

On April 30 the field work of triangulation for determining the positions of the necessary points was begun at Asbury Park, N. J.

Old stations Rumson, Wright, Ferris, Como, and Beach House were recovered, and observations were made at these and at the following stations: Long Branch Coast Guard station, Tower Hill 2, Takanassee, Windmill (Shadow Lawn), Windmill (U. S. E.), Shark River Coast Guard station, Squan Beach Coast Guard station, Observatory 2, Monterey Hotel, Spring Lake Coast Guard station, Deal Beach Coast Guard station, High School (Asbury Park).

In addition to the angles necessarily measured a large number of directions were measured to determine the positions of prominent objects.

The field work was completed on May 17.

The positions of the Coast Guard stations were afterwards computed and the geographic positions sent to the Washington office on June 26 for transmission to the naval authorities.

MARYLAND.

(J. A. DANIELS.)

SUMMARY OF RESULTS.—Triangulation: 42 square miles of area covered, 7 signal poles erected, 9 stations occupied for horizontal measures, 10 geographic positions determined.

Between March 22 and 29 and April 3 and 6 the positions of the fire-control towers upon the United States Ordnance Department Proving Ground on the east and west shores of Chesapeake Bay from Plum Point to Wortons Point were determined by triangulation.

The cupola of the Rod and Gun Club at Spesutie Island was used with Turkey Island as a base. To clear the line of sight it was necessary to cut a number of trees on the reservation near Mulberry Point.

All points located were marked by substantial stakes, which will be replaced by concrete monuments by the military authorities.

VIRGINIA.

(J. S. BILBY.)

SUMMARY OF RESULTS.—Reconnaissance (for primary traverse): Length of scheme 55 miles, 27 lines of intervisibility determined, 27 points selected for scheme. Primary traverse: 50 miles of primary traverse run, 27 observing tripods and scaffolds built, average height 18 to 20 feet, 27 stations in main scheme occupied for horizontal measures, 4 stations in supplemental schemes occupied for horizontal measures, 30 geographic positions determined. Leveling: 40 miles of levels run, 37 permanent bench marks established. Azimuth: 1 station occupied for determination of azimuth.

On May 2, 1918, preparations were begun at Portsmouth, Va., for running a line of precise leveling and primary traverse from the vicinity of Norfolk, Va., toward Savannah by way of Weldon and Raleigh, N. C., and Columbia, S. C.

During the early part of May triangulation stations were recovered in the vicinity of Norfolk, Va., signals built, stations occupied, and a connection made with a traverse station on the Virginian Railway. Traverse stations were also selected along the Virginian Railway, signals built, and the stations occupied. During the latter part of the month a traverse tape party and a leveling party were organized. During the latter part of May and early in June the work was much interfered with on account of labor problems. Wages paid by the Norfolk Naval Station for skilled workmen were very much higher than those paid by the Survey, and as a result many of the men left the Survey with the intention of securing work at Portsmouth and Norfolk. Nearly all of the positions in the Survey party were filled with new men, and by June 6 work was making satisfactory progress.

The work was begun from the triangulation stations to the southward of Portsmouth, and connected with the first traverse station which was selected near the Virginian Railway west of the Elizabeth River. Precise leveling was started from bench marks which had been established at the naval station at Portsmouth. Primary traverse and precise leveling were run along the Virginian Railway to a point about 3 miles east of Suffolk; then along the Seaboard Air Line Railway to Suffolk; then along the Virginian Railway to a point 3 miles west of Suffolk; and then continued along the Seaboard Air Line. By June 15 the levels were completed to a point about 5 miles to the westward of Franklin, the signal building had been completed about 15 miles to the westward of Franklin, and the tape measurement and observing party had completed work about 10 miles to the westward of Franklin. On June 16 the charge of the work was transferred to Max Steinberg.

VIRGINIA AND NORTH CAROLINA.

(MAX STEINBERG.)

SUMMARY OF RESULTS.—Primary traverse: Length of traverse 30 miles, 27 observing tripods and scaffolds built, average height of tripods and scaffolds 10 feet, 13 stations in main scheme occupied for horizontal measures. Precise leveling: 30 miles of precise levels run, 30 permanent bench marks established. Azimuth: 1 azimuth station occupied.

On June 16, 1918, the primary traverse party operating on the tracks of the Seaboard Air Line Railway between Norfolk, Va., and Savannah, Ga., was transferred to Max Steinberg by J. S. Bilby. At that time the work was completed to a point 3 miles south of Franklin, Va. By the end of the month, the work had been carried to Seaboard, N. C. Work was still in progress at the close of the fiscal year.

The entire party, consisting of four subparties, worked within a limited distance of 10 to 15 miles, and it was planned to continue this method. One railroad conductor was employed with the party.

NORTH CAROLINA.

[W. C. HODGKINS.]

SUMMARY OF RESULTS.—Triangulation: 20 square miles of area covered, 60 signal poles erected, 6 observing tripods and scaffolds built, height 15 feet, 54 stations in supplemental schemes occupied for horizontal measures, 180 geographic positions determined, 26 positions of floating objects determined.

The tertiary triangulation of the Cape Fear River was begun July 9, 1917. A preliminary examination was made for the purpose of obtaining a knowledge of the topography of the country to be traversed and the facilities available as to transportation, obtaining supplies, and assistance required in the work.

Useful information and aid were obtained from the officer of the Corps of Engineers, United States Army, in charge of the improvement of the Cape Fear River and from the officer of the United States Naval Reserve in command of the Wilmington section of the sixth naval district, and from other Government officials.

A suitable power launch was hired for the transportation of the party.

After recovering as many of the stations of the old triangulation as possible, a connected scheme of new stations was laid out, joined by suitable triangles to the bases furnished by the lines between the old stations. Considerable difficulty was experienced in this part of the work in Wilmington and its immediate vicinity because of the changes which have occurred since the date of the former work there and also because of the extreme narrowness of the river at that point, which has the effect of making the lines very short and of correspondingly increasing the necessary number of figures.

Seven stations of the triangulation of 1908 were recovered and three of the stations established in 1913. Twenty-two stations established and marked by the United States Engineers were recovered and used in the triangulation, either as regular stations or as intersection points.

Before the extension of the triangulation down the river, it was carried to the northward as far as Point Peter, at the junction of the northeast and northwest branches of the Cape Fear River, where connection was made with a permanent station of the United States Engineers.

The shores of the river are generally low, frequently swampy, and for the most part wooded, so that considerable difficulties were had in the matter of finding suitable sites for stations. Considerable clearing of trees and brush was required and several scaffold signals were found necessary.

Many of the stations were under water at high tide, and only three below Wilmington were much above the river level.

A reconnaissance for connection by a line of traverse between the triangulation of the Cape Fear River and the coast triangulation and for an extension of the coast triangulation was made.

An examination was made of tidal bench marks at Wilmington which had been connected with an automatic tide gauge established there in 1908.

Five of the seven bench marks were found to be in existence in apparently good condition.

Five new bench marks were established and marked with brass disk markers set in the walls of permanent buildings, and their elevations were determined by a double line of levels.

On account of unfavorable weather, work was closed for the season on January 16, 1918.

[CLEM L. GARNER.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 20 miles, 25 square miles of area covered, 74 lines of intervisibility determined, 32 points selected for scheme. Base lines: 2 secondary, 3 kilometers in length. Triangulation: 25 square miles of area covered, 29 signal poles erected, 2 observing tripods and scaffolds built, average height 10 feet, 34 stations in main scheme occupied for horizontal measures, 40 geographic positions determined. Leveling: 3 miles of wye levels run. Azimuth: 1 azimuth station occupied.

Between May 23 and June 30, 1918, a scheme of tertiary triangulation was completed connecting with the coast triangulation of 1914 south of Beaufort, N. C., and extending through Masonboro and Myrtle Sounds to the Cape Fear

River. The connection with the southern end of the triangulation in the Cape Fear River was made by a traverse from the south end of Myrtle Sound across the peninsula to the river.

A party was organized for establishing and marking stations and erecting signal poles. This party also staked out the base and traverse lines and prepared them for the measurements.

A second party was trained for observing horizontal angles and the chief of party, when time and other conditions permitted, also took part in this work.

The work was carried on in this manner until the last few days, when the bases and traverse were measured and azimuth observed, and leveling done over the base and traverse lines.

One small power boat and three small skiffs were used in the sounds for transporting the party. Some difficulties were encountered on account of the very shallow water in the sounds, and this was especially true at low water when there are many of the main channels which go dry. To avoid this the work was arranged to suit the tides as nearly as possible, and, except for a few days in Wrightsville Sound, there were only a few delays.

With 34 stations occupied in the main scheme, which close 58 triangles, the average closure was 3.6 seconds with 9 seconds the maximum. All observations, including the azimuth, were made with the 7-inch theodolite, following the field instructions for tertiary triangulation. The time observations for the azimuth were made with a vertical circle.

GEORGIA.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 52 miles, 89 points selected for scheme. Triangulation: Length of traverse 41.1 miles, 89 observing tripods and scaffolds built, 53 stations in main scheme occupied for horizontal measures and their geographic positions determined. Leveling: 18.6 miles of levels run (over stakes of traverse). Azimuth: 1 station occupied for observation of azimuth.

Work on the primary traverse from Brunswick to Columbus, Ga., via Macon, was in progress at the beginning of the fiscal year, having been carried to within 15 miles of Macon at the end of June. Progress made to that time is stated in the annual report for 1917, in which the methods followed are also briefly mentioned.

Motor velocipede cars were used for the transportation of the party.

During the season Lieut. Francisco Stewart, of the Argentine Naval Commission, visited the party for the purpose of inspecting the work with invar tapes.

On July 31 the charge of the party was transferred to George D. Cowie, the work having then reached the vicinity of Fort Valley, Ga.

[GEORGE D. COWIE.]

SUMMARY OF RESULTS.—Primary reconnaissance (traverse): 8 stations selected for main scheme. Primary traverse: 80 miles of traverse run, 87 stations occupied for horizontal measures. Azimuth: 2 azimuth stations occupied. Leveling: 23 miles of levels run.

The primary traverse party which had been under the charge of C. V. Hodgson operating between Brunswick and Fort Valley, Ga., was on August 1 transferred to George D. Cowie, who continued the work in the same manner as before.

Five motor cars were used for transportation of the party, instruments, and equipment on this work. These did not give satisfactory service, owing to frequent breakdowns and overloads.

The primary traverse line from Fort Valley to Upatol, Ga., was in a hilly country, and many curves delayed the work, on account of many short tangents and frequent scaling of high banks to reach the traverse stations.

At Upatol the traverse was changed to triangulation, and a connection was made with the triangulation stations of the party under charge of E. H. Pagenhart.

While this triangulation and signal building was being completed, a preliminary reconnaissance from Macon to Atlanta was made by R. V. Miller, which indicated that the line should follow the Central of Georgia Railway tracks from Macon toward Atlanta and change to triangulation when ground was favorable.

At Upatol a connection was made with a traverse station of the United States Geological Survey.

Azimuth was observed at Station "Fort" near Fort Valley and at a station near Butler, Ga.

On completing the work toward Columbus the party returned to Macon and started from some of the traverse stations, previously determined, traversing to a hill near the city reservoir, and then by secondary triangulation carried the line across the city to points north of Macon near Vineville Station, thereby avoiding a very crooked track, short tangents, and numerous signals. The points occupied in Macon were college towers.

By the end of September the line was carried to a point near Forsyth, Ga., and reconnaissance for primary triangulation from this point to stations on the eastern oblique arc of triangulation near Atlanta was practically completed.

As G. D. Cowie was transferred to the Coast Artillery Corps on the 24th of September, the work was placed in shape to turn over to O. W. Ferguson on the 30th.

Forked stakes were used to stretch the tape and later a form of stake designed by Mr. Pagenhart, which was an improvement.

The progress when the party was not engaged in triangulation was at the rate of approximately 70 miles per month.

[O. W. FERGUSON.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 101 miles, 1,474 square miles of area covered, 19 points selected for scheme, 152 points selected for traverse line. Triangulation: 735 square miles of area covered, 87 signal poles erected, 18 observing scaffolds and tripods built (average height 28.77 feet), 11 stations in main scheme occupied for horizontal angles, 49 traverse stations occupied, 79 geographic positions determined. Leveling: 226 miles of levels run, 205 permanent bench marks established.

By July 1, 1917, the line of precise levels from Brunswick, Ga., toward Macon, Ga., had been completed to 5 miles eastward of Eastman, Ga., and by July 26 the line was completed to Macon. Between July 27 and August 10 leveling was completed on a line from Macon to near Fort Valley; between August 17 and September 20 a line was completed between Macon and McDonough, Ga.; and between September 26 and October 22 a line from Macon to Griffin, Ga., was completed.

Motor cars were used for the transportation of the party and equipment, permission to use them having been obtained from the Southern Railroad Co., on condition of the employment of a conductor.

Adding machines were used for recording level readings.

The highest points at centers of the rails were at first used for rod supports. After reaching Macon the spikes were used for rod supports.

Standard bench marks were placed about every fourth mile. The traverse station marks were all determined as bench marks, and disk bench marks were set in railroad stations and other suitable places in every town, so that the average distance between bench marks is not more than 1 mile.

On September 26 charge of the party previously under the direction of G. D. Cowie engaged in traverse and triangulation work between Macon and Atlanta, Ga., was transferred to Mr. Ferguson.

It had been planned to run a line of traverse from Macon to Forsyth and another, for a base, from Barnesville to Griffin, and to execute a scheme of triangulation from Forsyth to Atlanta.

As soon as the precise leveling had been done and stations had been selected observations were begun on the triangulation.

On December 13 in accordance with instructions most of the party was transferred to Macon to work on the traverse from Macon to Savannah. Part of the force had been detached about a month before to begin this traverse work.

On January 16, 1918, the party was transferred to Jasper S. Bilby.

[J. S. BILBY.]

SUMMARY OF RESULTS.—Reconnaissance (for primary traverse): Length of scheme 176 miles, 210 lines of intervisibility determined, 210 points selected for scheme. Primary traverse: 210 observing scaffolds and tripods built (heights 8 to 20 feet), 210 stations in main scheme occupied for horizontal measures, 210 geographic positions determined. Leveling: 176 miles of levels run, 242 permanent bench marks, and 180 reference bench marks established. Azimuth: Azimuth observed at 3 stations on six nights.

On January 16, 1918, the charge of the party engaged in running a line of primary traverse from Macon to Savannah, Ga., was transferred by O. W. Ferguson to J. S. Bilby.

At that time a small scheme of reconnaissance had been completed for triangulation, a few signals built and stations made ready for observation, about 6 miles

of traverse line had been prepared, and tape measurements made over the prepared portion of the line. About 30 per cent of the measured line was on stakes, and as no stake levels had been run and most of the stakes had been removed by persons living in the vicinity, it was necessary to restake and remeasure that part of the line.

An inspection of the line of work showed that it would be necessary to have two parties to keep up the observing, and on account of car shortage it was not practicable to carry on the building, taping, stake leveling, keep two observing parties at work, and have cars for the precise leveling work. It was therefore necessary to postpone the leveling and to purchase new cars.

As the cars which had been in use were not suitable for the work, cars of a new type were obtained, and these were found satisfactory in every way.

During the month of February there were five subparties at work, as follows: One building party of 1 foreman-hand and 2 men, taping party of 7 men, stake-leveling party of observer and 1 man, and two observing parties, each consisting of 1 observer and 3 men. Early in March a precise leveling party was organized, which consisted of the observer and 4 men.

On March 22 the building, tape measurements, and stake leveling were completed to Savannah, and soon afterwards a second leveling party was organized, the leveling and observing was carried on, and by April 20 the observing had been completed. All field records were brought up to date and forwarded to the office. On May 1 the two leveling parties were left to complete the levels to Savannah and other members of the party moved to Portsmouth, Va., to take up work in that vicinity. By May 20 the levels were completed to Savannah, the records were forwarded to the office, and the leveling parties moved to Virginia.

The line of traverse and precise leveling between Macon and Savannah was run over the following-named railroads: Macon to Dublin, Macon, Dublin & Savannah Ry.; Dublin to Brewton, Wrightsville & Tennille Ry.; Brewton to Statesboro, Central of Georgia Ry.; Statesboro to Cuyler, Savannah & Statesboro Ry.; and Cuyler to Savannah, Seaboard Air Line Railway. The length of the line is about 175 miles. There are 205 primary stations, and nearly all stations of the primary traverse were made precise level bench marks. In addition to the traverse station bench marks, a precise level mark was established in each town along the line of work.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Primary traverse: 97 miles of traverse line measured with tapes, 60 signal poles erected, 83 observing tripods and scaffolds built (average height 3.6 feet). Leveling: 18 miles of levels run.

The traverse work in progress on June 30 in the vicinity of Willingham, Ga., was continued to Albany along the Atlantic Coast Line Railway, a distance of about 12 miles, and from Albany to Columbus over the Seaboard Air Line tracks.

The tape work was finished to Columbus on August 25, and construction work was completed August 31. On September 1 the party was turned over to another officer. On the date of transfer all of the work on the line had been completed with the exception of the observing, which was finished to the vicinity of Richland, leaving about 80 stations to be observed.

From Kimbrough to Columbus, the last 45 miles of the line, there is almost an entire separate scheme carried along the hills near the track to control the azimuth of the track stations. At Albany, Dawson, and Parrott the controlling azimuth was carried through lines by omitting some of the track stations.

Triangulation stations Cusseta and Columbus, which are situated on commanding hills near the railway to control the azimuth, will be connected with triangulation station Rich, near Upatol, a station on the Brunswick line. At Columbus the traverse expands into a five-point figure. Two of these stations were needed for control. The three additional ones were located on bare hills where only instrument stands were needed. This gave convenient points for later work.

[CLEM L. GARNER.]

SUMMARY OF RESULTS.—Reconnaissance (for traverse): Length of scheme 35 miles, 39 lines of intervisibility determined, 65 points selected for scheme. Primary traverse: Length of traverse, 25 miles, 39 signal poles erected, 83 observing tripods and scaffolds built (average height 12 feet), 11 stations in main scheme occupied for horizontal measures, 37 stations in supplemental schemes occupied for horizontal measures, 56 geographic positions determined. Leveling: 6 miles of levels run. Azimuth: 1 azimuth station occupied.

The party under charge of E. H. Pagenhart, engaged in running a line of primary traverse from Jacksonville, Fla., to Columbus, Ga., was, on September 1, 1917, transferred to Clem L. Garner, with instructions to run a line of primary traverse from Albany, Ga., toward Callahan, Fla., where connection was to be made with the Jacksonville-Columbus line of primary traverse completed earlier in the year. The party was taken to Albany, the starting point of the work, where the motor cars to be used in the work were repaired.

The traverse was begun September 4 and was continued to the south over the Georgia Northern Railway. This railroad is very crooked and contains on an average $1\frac{1}{2}$ curves to the mile, some of which are very long. The country is heavily wooded in patches and, being only slightly rolling, triangulation was not practicable. On September 29, 1917, the party was transferred to M. E. Lutz, at Doerun, Ga. The progress to that time was 25 miles.

The character of country and the very crooked road caused the lines between subsidiary stations to be slightly shorter than the average and also made necessary a great deal of clearing and staking in order to get around the curves. The azimuths for control, however, were always on lines more than a mile long, and the stations for these azimuths were strongly tied into the subsidiary stations, thus forming a very strong system of control.

[MAX STEINBERG.]

SUMMARY OF RESULTS.—Precise leveling: 208.3 miles of levels run, 130 permanent bench marks established.

On July 12, 1917, the charge of the precise-leveling party previously under charge of C. L. Garner at work on the line between Jacksonville, Fla., and Columbus, Ga., was transferred to Max Steinberg, at Columbus, Ga. The line was then continued along the Central of Georgia Railway to Bliss, Ga., to connect with the line run by O. W. Ferguson from Brunswick, Ga. On August 10, after connection had been made with the line from Brunswick, Ga., the party was moved to Albany, Ga., a distance of 80 miles. On August 11 work was begun on the Albany-Callahan line. The route lay along the Georgia Northern, Valdosta, Moultrie & Western and the Georgia Southern & Florida Railroads by way of Albany, Moultrie, and Valdosta, Ga., to Callahan, Fla. The line was carried as far as Council, Ga., on October 5. The party was then transferred to M. E. Lutz, to be continued by him in connection with the traverse over the same line.

In order to furnish the required information for the traverse party it was necessary to determine the elevation of the top of the rail at each point of curve, point of tangent, and opposite all permanent and temporary bench marks. Certain sections of the line were found to be a continuous series of curves. Between Albany and Moultrie, a distance of 38 miles, there were 68 curves. The progress of the party was necessarily retarded. Throughout the entire season conductors furnished by the railroads were employed in the party.

Permanent bench marks were set on the average about 1.6 miles apart.

[CLEM L. GARNER.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 55 miles, 1,000 square miles of area covered, 25 miles of intervisibility determined, 12 points selected for scheme. Triangulation: 1,000 square miles of area covered, 13 observing tripods and scaffolds built (average height 32 feet, with greatest height 57 feet), 13 stations in main scheme occupied for horizontal measures, 13 stations occupied for vertical measures, 32 geographic positions determined, 20 elevations determined trigonometrically.

Between April 1 and May 22, 1918, connection was made by primary triangulation between the primary traverse at Griffin, Ga., and the oblique arc of primary triangulation in the vicinity of Atlanta, Ga.

This work began on the line Wise-Jackson, which was a line of the first quadrilateral projected from the traverse between stations Hog Mountain and Wise as a base.

The country in this vicinity is rolling, with few hills of any prominence and heavily wooded in patches, which often occur on the tops of the hills, and necessitated the building of structures in order to bridge over them.

Some stations for the continuation of this scheme had been established and structures built over them. It was found, however, that several of the stands and scaffolds were blown down and that several of the proposed lines were not visible. As a result the entire scheme was changed. The length of lines was made to average about 12 miles, which reduced the length considerably from that originally proposed and proved to be a more economical length of line in a

country where haze and poor atmospheric conditions for observing prevail. With this length of line and the large electric lamps, few delays are to be expected on account of haze and bad seeing.

Two building parties of four men each were organized, while the chief of party did the reconnaissance and selected the stations. The work was delayed for about 10 days during the first part of April while there was a dense haze and smoke which made it impossible to determine the visibility of lines more than 6 miles long. Fortunately, the entire party was not delayed this amount of time, for several stations had been selected and the structures were put up during this time.

On the completion of the reconnaissance the building parties were drawn upon for enough men to begin the light keeping and recording, and only two men were left to complete the building. This was very practical, since the structures after this time were mostly small and could be well managed even by one man. Trucks and automobiles secured from local places were used in the transportation.

The equipment for the observing was practically the same as for the ordinary primary triangulation party except for trucks which have generally been used for transporting the party from place to place. On this work the light keepers moved by train, mostly hiring teams or automobiles to take them from station to railway, and vice versa. The observing party, for the most part, used Ford cars for carrying instruments from station to station. In addition to the usual equipment all light keepers were given a large electric lamp and batteries for use during bad haze or other atmospheric conditions which made seeing difficult. The acetylene lamps were used during ordinary conditions, since they were considerably more economical than the electric lamps.

The total number of stations occupied was 13, requiring one month from the time the observations were started until they were completed and the party left for other work in North Carolina.

The average closure for the work consisting of 18 triangles was 1.5 seconds, or a little more than that called for in primary triangulation. Considering, however, that the connection to the south was with a line of traverse over very crooked road where the accuracy could by no means be compared to the triangulation, it seemed inadvisable to reoccupy stations to reduce this mean closure.

GEORGIA AND SOUTH CAROLINA.

[MELVIN E. LUTZ.]

SUMMARY OF RESULTS.—Reconnaissance (for traverse): Length of scheme 227 miles, 174 points selected for scheme. Primary traverse: Length of traverse run 225 miles, 48 signal poles erected, 126 observing tripods and scaffolds built (average height of scaffolds and tripods 13.8 feet), 166 stations in main scheme occupied for horizontal measures, 66 stations in supplemental scheme occupied for horizontal measures. Leveling: 295 miles of precise levels and 28 miles of wye levels run, 149 permanent bench marks established. Azimuth: 10 azimuth stations occupied.

On January 1, 1918, active preparations were in progress for running a primary traverse and precise level line from Savannah, Ga., to Everett City, Ga., in compliance with instructions dated December 11, 1917. The route of this primary traverse and precise level line followed the main line of the Seaboard Air Line Railway from Savannah, Ga., to Everett City, Ga., and the level line was extended from Everett City, Ga., to Yulee, Fla. The latter section of the line was not covered by primary traverse.

This work was through timbered and marshy country, which was practically level. The conditions for traverse and leveling were ideal. The highest signal that it was found necessary to erect on this line was 18 feet in height. This work was pushed to completion rapidly, and on January 28 instructions were received to take up the work of extending primary traverse and precise levels from Savannah, Ga., to Norfolk, Va. On about February 3 the traverse work was completed to Everett City and the construction and traverse parties started working northward on the line toward Norfolk. The leveling party continued on to Yulee.

Permits had not been received for the use of motor cars on the main line northward from Savannah, and the work was carried forward for the first month and one-half by using local passenger trains as much as possible for the transportation of parties to and from the field, while the construction work which involved the transportation of materials of course could not be prosecuted in this manner. A 14-ton truck was rented in Savannah, and the construction work was pushed to a point 80 miles north of Savannah by this means.

The observing party had progressed on the Albany-Callahan line to Moultrie, Ga., at the first of the year. During the early part of January two observers were put on this work, so that this branch of the work would not lag so far behind. By the first of April the observing had been completed on the Albany-Callahan line, and was nearing completion on the Savannah-Everett line.

As it became necessary to secure more transportation of some kind in order to prosecute the work on the line north, the question was taken up with the superintendent of the Seaboard Air Line Railway system of getting permission for the use of motor cars. After some delay the desired permission to operate cars was granted. The motor truck was returned from Olar, S. C., to Savannah, and the motor cars, which had been laid up for two months, were put into use again.

The country over which this truck was used was decidedly unfavorable for its use, and it was put to a severe test. The roads were poor, the main difficulty being sand hub deep which would slow up and stall anything but the strongest car. It was necessary to run in low gear the greater portion of the time. Even with all these obstacles in the way of efficient transportation, it can be said for the truck that it is a feasible method of carrying on the work, but slower and more costly than by using motor velocipedes on the railway. The conditions were unfavorable for the truck in that the highways did not parallel the railway, and it was frequently necessary to make long detours to where the road crossed the railway in an effort to get material for signal building to the proper location.

The route of the primary-traverse and precise-level line northward from Savannah followed the main line of the Seaboard Air Line Railway. Of the work covered to the end of the fiscal year, that section lying between Savannah, Ga., and Norway, S. C., was ideal for traverse and levels. The country throughout this belt is level, fairly heavily timbered, and there are but few curves. From Norway, S. C., to Blaney, S. C., where the work had progressed at the end of the fiscal year, the country becomes more hilly and the conditions for traverse work are rather unfavorable—in some places difficult. Numerous long and sharp curves are encountered. It was necessary to carry a main scheme azimuth through this section somewhat independent of the tape work on the track but tied to the tape work at each main scheme station. The main scheme was carried through, however, without excessive building, the highest signal being 36 feet in height: It was necessary, however, to construct a number of signals of this height.

On February 21 instructions were received to make connection between the line of primary traverse passing the city of Savannah and the triangulation existing along the Savannah River. While other work was in progress this connection was made by the establishing of three quadrilaterals. On March 21 instructions were received for making a connection with the primary traverse line extending from Augusta, Ga., to Beaufort, S. C., via Fairfax, S. C. In order to carry out these instructions it was necessary to run a spur line of the primary traverse and precise levels to Allendale, S. C.

At the close of the fiscal year all branches of the work were under way at a point near Blaney, S. C.

GEORGIA AND FLORIDA.

[MELVIN E. LUTZ.]

SUMMARY OF RESULTS.—Reconnaissance (for traverse): Length of scheme, 160 miles; 160 points selected for scheme. Primary traverse: Length of traverse, 160 miles; 65 signal poles erected, 94 observing scaffolds and tripods built (average height of scaffolds and tripods, 13.3 feet), 47 stations in main scheme occupied for horizontal measures, 82 stations in supplemental schemes occupied for horizontal measures. Leveling: 15 miles of wye levels run, 48.8 miles of precise levels run, 22 permanent bench marks established. Azimuth: 2 azimuth stations occupied.

On October 1, 1917, the primary traverse party which had been under the charge of C. L. Garner was transferred to Melvin E. Lutz. The party was then located at Doerun, Ga., on the Georgia Northern Railway, and the invar tape and construction work had advanced to Bridgeboro, Ga.

On October 8 the precise leveling party under charge of Max Steinberg was transferred to Mr. Lutz and the precise leveling operations were suspended for the time being, as the level line had then been carried to the vicinity of Fargo, Ga., about 100 miles in advance of the work of the traverse party.

The route for the primary-traverse and precise-level line followed the Georgia Northern Railway to Moultrie, Ga.; thence via the Valdosta, Moultrie

& Western Railway to Valdosta, Ga.; thence via the Georgia, Southern & Florida Railway to Crawford, Fla.; thence via the Seaboard Air Line to Callahan, Fla., connecting at that point with the Jacksonville-Columbus primary traverse and level line.

The entire work was through timbered country which, in general, was practically level. From Bridgeboro to Moultrie, on the Georgia Northern Railway, conditions for traverse work were only fair, as many sharp curves and rather steep grades were encountered. The main scheme, however, was carried through this section without excessive building, the highest signal being 36 feet in height.

From Moultrie to Valdosta, a distance of 42 miles, conditions for primary-traverse work were also fair, some of the way very good. In some sections, however, numerous sharp curves were encountered. Through this section the main scheme was also carried forward without excessive building, the highest signal again being 36 feet in height.

From Valdosta to Callahan the work was carried forward under almost ideal conditions, the highest signal required being only 10 feet. One tangent 20 miles in length facilitated progress very much.

The best day's work for invar-tape measurements, under the most favorable conditions, was 7 miles of completed line. This distance was measured without working excessive hours and without undue fatigue to the members of the party. It was accomplished by a thorough coordination of each man's work so that there was no lost motion.

As previous experience proved that 2½ to 3 miles gave the most economical length of line for construction and observing, this length was adhered to throughout the progress of the work. It had also been found that very substantial tripods up to 36 feet in height could be built out of 2 by 4 lumber.

Careful attention was paid to the carrying through of a main-scheme azimuth where short lines were encountered, so that this portion of the work would not be weakened. The shortest main-scheme line established is seven-eighths of a mile in length.

When the primary-traverse work was carried forward to Fargo, Ga., the precise-level party was again organized and the levels were carried through to Callahan simultaneously with the primary traverse.

At the time of the transfer of the party, observations on the Jacksonville-Columbus primary-traverse line had not been completed, and the observer was working in the vicinity of Columbus, Ga. It took one month, or until the 1st of November, to complete the observation and azimuth work on that line.

Early in November the observer accordingly started on the Albany-Callahan line, and at the close of the calendar year had advanced as far as Moultrie, Ga.

Motor velocipedes were used throughout as a means of transportation. Altogether the party had eight motor velocipedes.

On December 11 instructions were received to establish primary-traverse and precise-level line between Savannah, Ga., and Everett City, Ga. By December 17 the construction and invar-tape measurements had been completed to Callahan, Fla., on the Albany-Callahan line, and this portion of the party moved to Savannah, Ga., to take up work on the new line. The precise-level line was completed to Callahan, Fla., on December 22.

At the close of the calendar year active preparations and outfitting were under way for the Savannah-Everett City line.

[W. B. FAIRFIELD AND J. E. McGRATH.]

SUMMARY OF RESULTS.—Latitude and longitude: 11 primary latitude stations established, 20 longitude differences (telegraphic) determined, signals exchanged on 85 nights.

During the period between August 17, 1917, and June 28, 1918, differences of longitude were determined between Atlanta and Hump (Macon), Ga.; Hump (Macon) and Fort Valley, Ga.; Hump (Macon) and Cochran, Ga.; Cochran and Mud (Eastman), Ga.; Mud (Eastman) and Joint (Hazelhurst), Ga.; Joint (Hazelhurst) and Jesup, Ga.; Jesup and Brunswick southeast base, Ga.; Brunswick southeast base, Ga.; and Fernandina, Fla.; Fernandina and Lancaster 2 (Jacksonville), Fla.; Lancaster 2 (Jacksonville), Fla., and Folkston, Ga.; Folkston and Waresboro, Ga.; Waresboro and Willacoochee, Ga.; Willacoochee and Valdosta, Ga.; Valdosta and Jones (Sumner), Ga.; Jones (Sumner) and Sylvester D, Ga.; Sylvester D and Kimbrough, Ga.; Kimbrough and Columbus E, Ga.; Columbus E and Butler, Ga.; Butler and Harmon, Ga.; Harmon and Riley, Ga.

From November 28 to December 31 very unfavorable weather was experienced.

Observations were made and exchange of signals had between Atlanta and Hump (Macon) on August 26 and September 6 and 7, completing the line.

Observations were made and exchange of signals had between Hump (Macon) and Forty Valley on September 18, 19, and 20, completing the line.

Observations were made and exchange of signals had between Hump (Macon) and Cochran on October 1, 3, and 4, completing the line.

Observations were made and exchange of signals had between Cochran and Mud (Eastman) on October 12, 13, and 15, completing the line. Observations for the determination of latitude were made at Cochran on October 15.

Observations were made and exchange signals had between Mud (Eastman) and Joint (Hazelhurst) on October 22, 23, and 24, completing the line. Observations for the determination of latitude were made at Joint (Hazelhurst) on October 30.

Observations were made and exchange of signals had between Joint (Hazelhurst) and Jesup on November 1, 2, 3, and 4, completing the line.

Observations were made and exchange of signals had between Jesup and Brunswick southeast base on November 16, 17, and 18, completing the line. Observations for the determination of latitude were made at Brunswick southeast base on November 24.

Observations were made and exchange of signals had between Brunswick southeast base and Fernandina on November 27 and December 1 and 2, completing the line.

Observations were made and exchange of signals had between Fernandina and Lancaster 2 (Jacksonville) on December 22, 28, and 30, completing the line. Observations for the determination of latitude were made at Lancaster 2 (Jacksonville) on January 15.

Observations were made and exchange of signals had between Lancaster 2 (Jacksonville) and Folkston on January 25, 26, 28, and 29, completing the line.

Observations were made and exchange of signals had between Folkston and Waresboro on February 7, 8, 9, and 10, completing the line.

Observations were made and exchange of signals had between Waresboro and Willacoochee on February 23, 24, and 25, completing the line.

Observations were made and exchange of signals had between Willacoochee and Valdosta on March 12, 13, 14, and 15, completing the line.

Observations were made and exchange of signals had between Willacoochee and Jones (Sumner) on March 25, 26, and 27, completing the line. Observations for the determination of latitude were made at Jones (Sumner) on April 2.

Observations were made and exchange of signals had between Jones (Sumner) and Sylvester D on April 13, 15, and 16, completing the line. Observations for the determination of latitude were made at Sylvester D on April 22.

Observations were made and exchange of signals had between Sylvester D and Kimbrough on April 28 and May 1 and 2, completing the line. Observations for the determination of latitude were made at Kimbrough on May 3.

Observations were made and exchange of signals had between Kimbrough and Columbus E on May 8, 9, 10, and 11, completing the line. Observations for the determination of latitude were made at Columbus E on May 18 and 19.

Observations were made and exchange of signals had between Columbus E and Butler on May 21, 22, and 24, completing the line. Observations for the determination of latitude were made at Butler on May 25.

Observations were made and exchange of signals had between Butler and Harmon on May 31 and June 1 and 13, completing the line. Observations for the determination of latitude were made at Harmon on June 15.

Observations were made and exchange of signals had between Harmon and Riley on June 16, 18, and 19, completing the line. Observations for the determination of latitude were made at Riley on June 22.

The Western Union Telegraph Co. cooperated with the observers in this work, making all the connections when required and seeing that everything necessary was done in a very prompt and efficient manner.

On June 25 arrangements were made to begin observations for the determination of the difference of longitude between Riley and Fort Valley, but on June 27 the work was temporarily suspended in order to make certain measurements on the traverse lines in the vicinity of Macon.

The distances between traverse stations Ira and Amons at Forsyth, Ga., and stations Rock and Martin at Vineville, Ga., were measured with a steel tape. Traverse station Gun at Jeffersonville, Ga., was recovered and the difference of

elevation between it and the reference mark was determined. This work was completed on June 29.

In order to expedite the longitude work the sites of the stations were selected and the observatories built in advance of the arrival of the observers.

FLORIDA, GEORGIA, AND ALABAMA.

[G. D. COWIE.]

SUMMARY OF RESULTS.—318 miles of levels run, 116 permanent bench marks established.

Between January 1 and April 5, 1917, the line of precise leveling between Tallahassee, Fla., and Mobile, Ala., was continued from the vicinity of Birmingham to Mobile, Ala.^a

Connections were made during the period covered by this abstract with several bench marks of the precise levels of the Tennessee Coal & Iron Co. south of Birmingham and with bench marks of the United States Engineers at the Coosa River, Ala., and at the Tombigbee River, Ala., near Jackson.

The above connections were close and afforded excellent checks on the work.

On this line connections had been made with the United States Geological Survey bench marks at Columbus, Ga., at several places between Columbus and Atlanta, Ga., between Atlanta and Birmingham along the Seaboard Air Line tracks, and between Birmingham and Ashby, Ala.

MISSISSIPPI.

[H. G. AVERS.]

SUMMARY OF RESULTS.—Precise leveling: 22 miles of levels run. 13 permanent bench marks established.

Upon the completion of the lines of levels to Point Isabel, Tex., the observer proceeded, on February 13, 1918, to Biloxi, Miss., arriving there February 16, 1918.

On February 18, 1918, work was begun on a line of precise levels to extend from Biloxi, Miss., to River Junction, Fla., over the tracks of the Louisville & Nashville Railroad. Connections were made with several bench marks of the United States Engineers at Biloxi, and the line was then extended to the tide gauge of the United States Engineers on Biloxi Bay.

At the tide gauge connections were made with the tide staff and with the reference bench marks.

After leaving the tide gauge the level line follows the Louisville & Nashville Railroad through Ocean Springs and Pascagoula, Miss.

In accordance with instructions of February 27, 1918, the chief of party was relieved of this work by Douglas Karr on March 5, 1918, the line having been completed to Pascagoula, Miss., at the time.

MISSISSIPPI, ALABAMA, AND FLORIDA.

[DOUGLAS KARR.]

SUMMARY OF RESULTS.—Precise leveling: 184 miles of precise levels run, 84 permanent bench marks and 149 temporary bench marks established.

On March 5, 1918, Douglas Karr relieved H. G. Avers of the charge of the precise leveling party operating on the line from Biloxi, Miss., to River Junction, Fla. The work had then been completed to Pascagoula, Miss.

The work was afterwards carried along the line of the Louisville & Nashville Railroad, and by June 30 was completed to a point 15 miles east of Pensacola, Fla.

A spur line of levels was run from Theodore, Ala., to Bayou la Batre and Alabama Port, Ala., to connect with the tide staffs established by the party on the U. S. *Hydrographer*. A short spur line was also run at Mobile, Ala., to connect with the tide staff established there by the U. S. *Hydrographer*.

For practically all permanent bench marks the regulation United States Coast and Geodetic Survey disk was used. Care was taken to always set these disks in substantial structures. Reinforced concrete posts, with the disk set

^a In the annual report for 1917 the abstract of the portion of this work done between Jan. 1, 1917, and Apr. 5, 1917, was accidentally omitted. It is here inserted, although belonging to another fiscal year, in order that the record may be complete.

in the top, were also used as bench marks. In placing these posts care was taken to select good ground, and they were well tamped in place.

Temporary bench marks were lag screws driven in mileposts, rail-rack posts, or telegraph poles, whichever appeared more solid and enduring. Ordinary railroad-track spikes driven in structures and tie bolts on bridges were also used.

The equipment consisted originally of two velocipede motor cars, on one of which the instrument was mounted and upon the other the adding machine. These cars were new and gave good service. A motor car of different make was afterwards received from another party and gave good service.

LOUISIANA AND TEXAS.

[MAX STEINBERG.]

SUMMARY OF RESULTS: Precise leveling: 498 miles of levels run, 806 permanent bench marks established.

The line of levels completed by this party between January 18 and June 1, 1918, extends from Sinton, Tex., by way of the St. Louis, Brownsville & Mexico Railroad to Houston, Tex.; then continues eastward over the Southern Pacific Railroad to New Orleans. Spur lines were run to the Gulf coast from Placedo to Port Lavaca, Tex., over the Galveston, Harrisburg & San Antonio Railway; Bay City to Matagorda, Tex., over the Gulf, Colorado & Santa Fe Railway; Angleton to Freeport, Tex., over the Houston & Brazos Valley Railroad; Beaumont to Sabine Pass, Tex., over the Southern Pacific Railroad.

On June 1 the party was transferred to Casper M. Durgin. At that time the line was completed to Estherwood, La. The above work, as well as that previously reported upon during this year, was done at the request of the Chief of Engineers of the United States Army to furnish vertical control for topographic surveys.

At Sinton the line was started from three Coast and Geodetic Survey bench marks established several months earlier. Connection was made with three Coast and Geodetic Survey bench marks at Houston, Tex. Connections were also made with one tidal bench mark at Quintana, Tex., several United States Geological Survey bench marks on the Southern Pacific Railroad east of Houston, one United States Army Engineer bench mark on the west abutment of the Texas & New Orleans Railroad bridge at Beaumont, Tex., and with the line of United States Geological Survey bench marks on the Southern Pacific Railroad east of Jennings, La. A careful search was made for the old tidal bench marks established by the Survey at Matagorda and Velasco, but only one, the top of an iron pipe of an artesian well at Quintana, near Velasco, could be found. The terminals of the spur lines to the coast were well marked with plates in permanent structures and will doubtless be easily recovered for use in connection with future hydrographic work.

The officials of the Southern Pacific Railroad having refused permission for the operation of our motor cars over that road between Houston and New Orleans, on account of the heavy traffic and frequent fogs, the motor cars were shipped to C. L. Garner, at Wilmington, N. C. The party then proceeded to level on foot. A motor truck was secured for use in carrying the observing party to and from work. This was found to be very convenient as long as the highway paralleled the railroad.

Permanent bench marks were placed on the average of $1\frac{1}{2}$ miles apart. Many of the temporary marks on the Southern Pacific line, such as corners of concrete bases of fairly massive block signals, are of a permanent character and can be readily recovered, but are not marked. The total number of permanent and temporary bench marks were placed on the average of one bench mark to eight-tenths of a mile. Of the permanent marks, 122 are square concrete posts with the standard metal disk set flush with the top. One hundred and eighty-four standard metal plates were set in buildings, bridge abutments, and concrete culverts.

[CASPER M. DURGIN.]

SUMMARY OF RESULTS.—Precise leveling: 61.6 miles of levels run, 48 permanent bench marks established.

On June 1, 1918, when the charge of the work was transferred to Casper M. Durgin, the line of precise levels extending from Sinton, Tex., to New Orleans, La., begun by Max Steinberg on January 18, 1918, had been carried from Sinton,

Tex., to Estherwood, La., 28 miles west of Lafayette, La., with spur lines from the main line to the following places: Port Lavaca, Tex.; Matagorda, Tex.; Velasco, Tex.; and to Sabine Pass, Tex.

During the month of June, 1918, this line of levels was continued along the main line of the Southern Pacific Railroad from Estherwood, La., to Jeanerette, La., a distance of 61.6 miles.

A motor truck was used for the transportation of the party, and, although not so well adapted to the work as the motor-velocipede cars, was found to be very efficient, except for the 10 miles between Rayne, La., and Scott, La., where the highway left the railroad and was in poor condition as a result of heavy rains. The truck was laid up on two occasions for repairs, once for a period of 12 days. At these times it was necessary to make use of railroad trains or hired automobiles. In a few cases the railroad trains were the only recourse, as the roads were unfit for travel. During the latter part of the month, however, there was very little rain and a good highway followed very closely to the railroad.

The number of permanent bench marks established during the month of June was 48, making an average of 1 permanent bench mark to every 1½ miles. Of these bench marks 22 were plates set either in brick buildings or in concrete abutments of railroad or highway culverts. Seven concrete posts were set and 2 bench marks were established on the concrete bases of block signals. A line of precise levels made by the United States Geological Survey in 1906 followed the Southern Pacific Railroad throughout the entire section of the line run during the month of June, and 15 of the permanent bench marks set at that time were recovered and connected with.

TEXAS.

[J. S. BILBY.]

SUMMARY OF RESULTS.—Reconnaissance. Length of scheme, 420 miles, 3,630 miles of area covered, 350 line of intervisibility determined, 119 points selected for scheme. Base lines: 5 sites for base lines selected, 1 base line site (primary) prepared. Triangulation: 81 observing tripods and scaffolds built, 38 tripods built, without scaffolds (average height to tripod head above mark, 14.72 feet).

At the close of the fiscal year June 30 a party had been organized and equipped at Harlingen, Tex., to make a reconnaissance and build signals and instrument stands in preparation for an observing party on the Rio Grande arc of primary triangulation.

On July 2 the party moved to station Donna near the town of Donna, Tex., where a 60-foot signal was erected and work begun.

The building party was divided into two subparties, each consisting of one foreman and three hands. Each of the subparties was provided with one Packard 1½-ton truck, one team of mules and wagon, one White 1-ton truck, and the necessary tools and miscellaneous outfit. This organization was maintained during the month of July while engaged in building large signals in the Rio Grande Valley between Donna and Rio Grande City.

The trucks were used for hauling all material, lumber, and supplies, no extra transportation being supplied. The men employed on the actual building work also drove the trucks and team.

Early in August the number of hands was reduced on account of the changed conditions and character of the country, which made it impracticable to continue the use of large tripod and scaffold signals. One Packard truck and one White truck were turned over to the chief of the observing party.

The reconnaissance was executed by the chief of party alone, using a one-half ton truck for transportation of himself and of the necessary instruments, tools, bedding, and cooking utensils. The chief of party also had personal charge of all transportation of material and supplies for the two subparties.

The work was begun from stations Donna-Rio. The character of the country east of the Pecos River was such that only a small scheme was practicable.

Connection was made with reconnaissance stations located by E. H. Pagenhart in the vicinity of Sanderson, Tex.

The length of the scheme from Donna-Rio to the stations with which connection was made near Sanderson is 420 miles, and there are 119 stations in the scheme. The actual work was begun July 2 and was completed December 1. The actual time occupied in field work was five months, the stations occupied averaging 23.8 per month. The necessary building was done at all stations and the stations were marked and made ready for the observing party.

After closing work arrangements were made for preparing base lines for measurement.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Triangulation: Length of scheme 61 miles, 370 square miles of area covered, 7 observing tripods and scaffolds built (heights averaging 12 feet), 19 stations in main scheme occupied for horizontal measures, 19 stations occupied for vertical measures, 56 geographic positions determined, 56 elevations determined trigonometrically, 1 azimuth (Laplace) station established.

Reconnaissance and signal building having been sufficiently advanced and necessary repairs having been made to the automobile trucks used for the transportation of the party, observations were begun August 23 in the vicinity of Harlingen, Tex., on the arc of primary triangulation westward along the Rio Grande River.

The reconnaissance provided a very small scheme of triangulation with lines about 10 or 12 miles long at the beginning and decreasing to half that length after five or six figures. At first the country traversed was partly irrigated, with considerable native mesquite growth 30 or 40 feet high, but farther west the height of the vegetation was not more than 20 or 30 feet. The towers were a corresponding height, varying from 60-foot tripods with a 20-foot superstructure at the beginning to stands and 35-foot tripods with 20-foot superstructure farther west. Owing to the difficulty of obtaining lumber and the cost of transportation, the towers were very lightly constructed, the 35-foot tripods having legs made up of only two by four pieces spliced together. This method of building was found to give insufficient stability in azimuth to the tripod in high winds.

Three automobile trucks were used for the transportation of the party.

The party left Harlingen for the first station on August 28 and closed observations to prepare for the transfer of the party on September 28. During that period 19 primary stations were completed and 61 miles of progress were made through the center of the scheme.

In this work an 8-inch Wanschaff direction theodolite belonging to Columbia University was used, instead of the usual 12-inch theodolite, with satisfactory results.

Thirty-three triangles gave an average closure of 0.91 second and a maximum of 2.51 seconds with one reoccupation for closure. The azimuth station, a Laplace station with two night observations, gave a probable error for the station of 0.17 second.

Field work was closed September 28, and arrangements were made for the transfer of the party to C. L. Garner.

[E. H. PAGENHART.]

RECONNOISSANCE.—Length of scheme 140 miles, 4,000 square miles of area covered, 16 primary and 3 supplementary points selected for scheme. Base lines, 1 primary selected. Primary triangulation: Length of scheme 250 miles, 5,500 square miles of area covered, 34 stations occupied for horizontal measures, 34 stations occupied for vertical measures, 46 geographic positions determined, 45 elevations determined trigonometrically. Azimuth: 4 azimuth stations occupied. Base lines: 5 primary base lines measured. Precise leveling: 145 miles of single line of levels run.

After transferring the traverse party in Georgia to C. L. Garner, E. H. Pagenhart proceeded to Brownsville, Tex., where he organized and outfitted a party for reconnaissance and primary triangulation along the Rio Grande arc. The party then moved by motor truck to Marfa, Tex., at the western end of the Rio Grande arc. The reconnaissance work was started at Marfa on October 15, and was continued toward the southeast to a point near the Dryden base line, where the work was joined later to that of J. S. Bilby.

About November 4 the party returned to Marfa and started work on the triangulation. On March 2 the triangulation was completed to a point near Del Rio, Tex., where it joined the work of the other party under C. L. Garner, who had been working westward on the eastern end of this same arc.

Mr. Pagenhart then reorganized his party into a base-line party and started work on the measurement of five base lines along the Rio Grande arc. These were completed about April 20, and Mr. Pagenhart, with a part of his party, proceeded to Harlingen, Tex., to do precise leveling.

Between April 26 and May 17 check levels were run from a bench mark near Robstown to a bench mark near San Benito to locate an error of 1 meter in the precise-level line between Sinton and Brownsville, Tex.

[CLEM L. GARNER.]

SUMMARY OF RESULTS.—Triangulation: 3,500 square miles of area covered, 4 signal poles erected, 4 observing scaffolds and tripods built, 79 stations in main scheme occupied for horizontal measures, 79 stations occupied for vertical measures, 215 geographic positions determined, 200 elevations determined trigonometrically, length of scheme 275 miles. Azimuth: 5 azimuth stations occupied.

Between October 3, 1917, and March 2, 1918, observations were made in the primary triangulation along the Rio Grande arc from a point 5 miles west of Rlogrando to the vicinity of Del Rio, Tex., a total distance along the line of progress of 275 miles. Seventy-nine stations in the main scheme were occupied for horizontal and vertical measures, five of which were azimuth stations. The work of this party closed about 20 miles northwest of Del Rio, Tex., where the observations were joined to those of E. H. Pagenhart, who made the reconnaissance and observations for the western end of the arc.

Intersections were measured on many objects in the usual manner for the purpose of locating them geographically, and when at all possible a third intersection was taken to act as a check. With the exception of objects in the towns and the few mountain peaks in Mexico, practically all of these objects were windmills. For that reason they were very difficult to identify, and this could only be done by plotting them on a progress sketch. It is believed, however, that enough of these can be sufficiently well identified to give very good control for any future work in that country.

Several mountain ranges in Mexico were visible from the vicinity of the work and as many of these peaks were determined as possible. They were long distances away and were rarely sufficiently visible for definite pointings, and never clearly enough seen for vertical measures, except at the very worst hour of the day, viz, about dusk. For that reason very few vertical measures were made on them.

All of the instruments used were of the same character as those previously used on primary triangulation, excepting the theodolite, which was an 8-inch Wanschaff direction theodolite with an exposed circle 2 micrometers 180 degrees apart and a stride level with a value of slightly more than 9 seconds for each division of the bubble.

White trucks Nos. 3 and 4 and a 1½-ton Packard truck loaned the Coast and Geodetic Survey by the quartermaster at Fort Sam Houston were used for transportation of the party and equipment from the beginning of the work until January 5, 1918, when the Packard truck was called for by the quartermaster. This was immediately delivered to the proper authorities and in its place a light three-fourths ton Republic truck was loaned by the department engineer at Fort Sam Houston, Tex. This was returned to the department engineer at the close of the work during the first of March, 1918.

The use of three trucks was made necessary on account of the character of the country, and proved a very economical and efficient method. It has been the custom in the past to use two trucks to move the observing party, while the light keepers traveled by train and wagon or other conveyance, as the conditions afforded. This was when the scheme of triangulation was large and a third truck could not make the moves as quickly as they could be made by other travel. In this work, however, the scheme was small, with the average length of line about 10 miles across a country where the railroad facilities were of little use and where very few people live. The use of a third truck in this case was about the only solution and worked very satisfactorily. This method was started by Mr. Hodgson and was continued to the end of the season.

During the season of five months 79 stations in the main scheme were occupied, with an average of 16 stations per month. There were 175 triangles closed, with an average closure at the end of the season of 0.995 second. For the first three and one-half months of the season the average closure was 4.93 seconds, but it was increased at the end of the work on account of unfavorable weather and poor conditions for observing in general.

[J. D. POWELL.]

SUMMARY OF RESULTS.—Precise leveling: 108½ miles of levels run, 54 permanent bench marks established.

The work of precise leveling between Sierra Blanca and San Antonio, Tex., undertaken at the request of the War Department in the previous fiscal year, was in progress on July 1, two parties being engaged in the work.

The party under charge of J. D. Powell was working from Del Rio to the eastward, and had made about 100 miles of progress by June 30, 1917.

On July 18 instructions were issued to Mr. Powell, then at Del Rio, after finishing the work contemplated by his original instructions, to continue alone the line of levels to San Antonio, Tex., and run a spur line of precise levels from Spofford to Eagle Pass.

On September 26 Mr. Powell, who had then moved to San Antonio, was directed to transfer the charge of the precise-leveling party and outfit to Douglas Karr, who assumed charge of the party on October 13. The headquarters of the party was then at Pearsall, Tex.

The party was operating along the line of the International & Great Northern Railway between San Antonio and Laredo, and the work had progressed to a point about 1 mile south of Natalie, Tex.

[DOUGLAS KARR.]

SUMMARY OF RESULTS.—Precise leveling: 127 miles of levels run, 81 permanent bench marks established.

On October 6, 1917, the charge of the precise-leveling party under J. D. Powell, at work between San Antonio and Laredo, Tex., along the line of the International & Great Northern Railroad, was transferred to Douglas Karr.

The work, which had then progressed to a point about a mile south of Natalie, Tex., was continued toward Laredo, and the line was completed about December 31.

Two motor cars were used in this work, to which they were well adapted. The level tripod was mounted on one of these cars and the adding machine on the other.

Standard Coast and Geodetic Survey bench-mark disks were set in numerous substantial stone or concrete structures along the line, and limestone posts were used as additional bench marks and set approximately every 2 miles along the line, and as nearly as practicable at the even mileposts. These posts were set so as to project about 6 inches out of the ground. For temporary bench mark railroad-track spikes were driven in telegraph poles at or near the odd-numbered mileposts.

[O. W. SWAINSON.]

SUMMARY OF RESULTS.—Precise leveling: 215 miles of levels run, 110 permanent bench marks established.

At the beginning of July, 1917, a line of precise levels was being run along the Southern Pacific Railroad eastward from Tesnus, Tex. The work was continued during July until it joined the line run by John D. Powell at Meyers Canon No. 2 Bridge on July 27.

In accordance with instructions the party was then moved to San Antonio, Tex., and began a line of precise levels from New Braunfels southward toward Brownsville, Tex.

The line from New Braunfels to San Antonio was carried over the Missouri, Kansas & Texas Railway. From San Antonio to Sinton it was carried over the San Antonio & Aransas Pass Railway.

Permanent bench marks were established in all of the principal railroad stations in San Antonio. They were also placed at or near every even-numbered milepost along the railroads and in the buildings in the principal cities. These bench marks consisted of a standard United States Coast and Geodetic Survey brass bench mark set in 6-inch diameter concrete posts about 6 inches above the ground, or in the outcropping country rock, or in stone or concrete bridges, culverts, etc., or in the foundations of the buildings.

Temporary bench marks were established at or near every odd-numbered milepost. These consisted of railroad spikes driven in the telegraph poles, bridges, culverts, etc. Sometimes only one spike was driven in the pole and sometimes three, two to serve as a protection for the one used as a bench mark.

On October 5 O. W. Swainson received orders from the War Department to report at the Coast Artillery School at Fort Monroe, Va., and on that date the charge of the party was turned over to H. G. Avers.

[H. G. AVERS.]

SUMMARY OF RESULTS.—Precise leveling.—225 miles of levels run, 90 permanent bench marks established.

On October 5, 1917, the charge of the party engaged in extending a line of precise levels from New Braunfels to Brownsville, Tex., was transferred by O. W. Swainson to H. G. Avers.

The level line at that time had been completed to a point 15 miles north of Sinton, Tex., on the San Antonio & Aransas Pass Railroad. Upon completing the line to Sinton work was begun on the line south of Sinton toward Brownsville, Tex.

From Sinton to Brownsville, Tex., 162 miles, the line follows the St. Louis, Brownsville & Mexico Railway through a perfectly level and unbroken country. The principal towns along the railway are Robstown, Kingsville, Riviera, Raymondville, Harlingen, and San Benito.

At Robstown, Tex., a 25-mile spur was run to Corpus Christi over the Texas & Mexico Railway to connect with the United States Engineer bench marks at that place.

From Brownsville, Tex., the line was extended 22 miles to Point Isabel, Tex., over the tracks of the Rio Grande Railway and connection was made with the Coast and Geodetic Survey and the United States Geological Survey bench marks at that place.

A cylindrical cement post weighing about 75 pounds, with a disk in the top, was used for a permanent bench mark where there were no buildings or other structures available for placing the disk. The condition of recovered bench marks showed very plainly that a stone or cement bench mark having sharp corners should not be used. Any corner or projection invites mutilation.

Spikes in telegraph poles were used almost entirely as temporary bench marks.

MAGNETIC WORK.

MARYLAND.

CHELTHENHAM MAGNETIC OBSERVATORY.

[GEORGE HARTNELL.]

During the year the work of the Cheltenham Magnetic Observatory was continued as outlined in previous annual reports.

All of the observatory instruments were in satisfactory operation.

Thirty-four earthquakes were recorded during the year.

On September 27 and 28 the periods of both components of the seismograph were reduced to 15 seconds, which is as short a period as can be obtained with the present mounting and range of adjustment.

Styluses constructed from the indices of minimum thermometers suitably mounted have proven a great improvement over styluses having wire for the recording points in that the friction is materially reduced. It is understood that some seismological stations are using satisfactorily metal styluses with rounded points.

In March, 1918, it was found necessary to forward the large earth inductor No. 26 to the office for repairs to the commutator. Since its replacement at Cheltenham, the inductor has performed very satisfactorily.

Magnetometer No. 26 and Cooke magnetometer No. 40 were compared by means of 10 sets of observations during February. The relationship between these magnetometers appears not to have changed since No. 40 was purchased in 1915.

During April a series of observations was made with the D and Z variometers of magnetograph No. 5 to redetermine the Z distribution factor and to determine the effect of the slight eccentricity of the deflector with reference to its carriage. Of the four distances used, three gave perfectly consistent scale values, while the distance 26 centimeters gave an abnormally high value. This effect has been attributed to a roughness or an irregularity of the pivots of the Z magnet in the position corresponding to the deflections at that distance. No change in the distribution factor was indicated. As regards the slight differences between the distances of the magnets due to carriage, the deflections did not always confirm the measurements. To avoid any error from this cause the magnet carriage is used in direct and reversed positions during deflections.

Beginning with November, 1917, the values of H derived from both magnetographs on the days of absolute observations have been plotted, thus providing a correct idea of the behavior of the two variometers.

On May 15, 18 sets of dip were made with earth inductor No. 26 at half-hour intervals during the day. From these observations and the mean Z base line a diurnal curve of H was derived. The fact that the curve thus derived fitted in between the H curves plotted from the variometers would indicate that earth inductor No. 26 is capable of determining the dip with a high degree of accuracy.

REPORT OF SUPERINTENDENT, COAST AND GEODETIC SURVEY. 739

Earth inductor No. 22 was compared with No. 26 on May 7 and 21, the mean correction of No. 22 being 0.8 foot on both days:

Beginning with the month of March, 1918, the temperature coefficient of Z variometer No. 1 has been regarded as zero, a value which much better satisfies the trend of the base lines over a considerable interval of time.

FLORIDA.

[J. R. BENTON.]

On June 8, 1918, observations were made at the time of the solar eclipse at Orlando, Fla., in the belt of totality. The usual magnetic observations (declination, dip, intensity) were made in the morning, and in the afternoon observations of the declination were made every minute for about five hours, during which the totality took place. The end of this last set of observations was interfered with by rain.

NORTH CAROLINA AND SOUTH CAROLINA.

[J. R. BENTON.]

STATIONS OCCUPIED.—North Carolina: Aberdeen,* Goldsboro,* Raleigh,* Rockingham, and Wadesboro. South Carolina: McBee, Cheraw, Laurens, and Chester.*

Observations of the three magnetic elements were made at the stations named above in July, 1917.

Old stations were reoccupied at the places marked by asterisks (*). The old stations at Laurens, Wadesboro, and Rockingham were no longer suitable, so new stations were established and permanently marked. The other stations on the list, except Aberdeen, were not marked.

At Chester, Wadesboro, and Rockingham auxiliary stations were occupied to determine the extent of the local magnetic disturbance. At Chester eight points were occupied, at several of which the declination seemed to be normal, while at others it was widely disturbed; and at Wadesboro and Rockingham four auxiliary stations each were occupied, each about 7 miles from the center of the disturbance, in the directions east, south, west, and north.

ARIZONA, CALIFORNIA, NEVADA, OREGON, AND WASHINGTON.

[H. E. McComb.]

STATIONS OCCUPIED.—Arizona: Yuma† and Tucson†. California: Alderpoint,* Bars-tow,† Brown,* Carlsbad,* Cloverdale,* Crescent City, Death Valley,* Dos Rios,* Eureka,* Fort Bragg,* Hanford, Independence, Indio,† Lakeport, Laws,* Monrovia,* Niland,* Orick,* Point Reyes,* Riverside, San Bernardino,† Santa Ana, Scotia,* Silver Lake,* Stockton,† and Tecopa.* Nevada: Beatty,* Bonnie Clare,* Goldfield, and Mt. Montgomery.* Oregon: Bend, Coquille, Culver, Dallas, Elkton,* Eugene† and 7 auxiliaries, Gold Beach, Hood River and 8 auxiliaries, Langlois,* Mohler,* Oakridge,* Oregon City, Pacific City,* Portland,† Reedsport,* St. Helena and 7 auxiliaries, and Tillamook. Washington: Ber-lin,* Cathlamet and 5 auxiliaries, Cle Elum,* Eagle Gorge,* Pateros,* Prosser, Seattle,† Waterville, and Wenatchee.

During the time from July 1 to November 1, 1917, observations of the three magnetic elements were made at the stations named.

The stations indicated by an asterisk (*) were not permanently marked. Old stations were reoccupied at the places indicated by a dagger (†). All other stations were permanently marked.

At Tucson four sets of magnetic observations were made in order that the instruments might be compared with those of the observatory. For this purpose simultaneous observations were made.

ALABAMA, ARKANSAS, COLORADO, GEORGIA, LOUISIANA, MISSISSIPPI, NORTH CAROLINA, AND TEXAS.

[WILLIAM W. MERRYMON.]

STATIONS OCCUPIED.—Alabama: Mobile* and Selma.* Arkansas: Mena.* Colorado: Colorado Springs, Edgerton, Fountain, Glen Eyrie, Manitou, Manitou Junction, Pikeview station, and Rosemont. Georgia: Blairsville, Hiwassee, Lagrange,* Palmetto, and Red Oak. Louisiana: Alexandria* and Shreveport.* Mississippi: Brookhaven.* North Carolina: Marion* and Murphy.* Texas: Fort Worth, Greenville,* Sherman, and Tex-arkana.*

Old stations were reoccupied at the stations indicated by an asterisk (*).

Between March 23 and June 30, 1918, the three magnetic elements were observed at each of the stations mentioned in the foregoing list.

Special observations were made at the time of the solar eclipse of June 8, 1918, at Mena, Ark., in connection with similar observations made at a number of other places in the belt of totality. They included observations of declination every minute for a period of six hours, with observations every half minute during the 20-minute period about totality. The observations at Colorado Springs and vicinity were made in cooperation with the department of terrestrial magnetism of the Carnegie Institution of Washington to determine whether there is any change of the earth's magnetic field due to changes of elevation.

Four auxiliary stations were occupied in the country around Marion, N. C.

A meridian line was established at the new magnetic station at Sherman, Tex., at the request of the city manager.

Requests for magnetic data were made by local surveyors and engineers or local authorities at most of the stations occupied.

The new stations occupied at Red Oak and Palmetto, Ga., and at Fountain, Manitou Junction, Manitou, Glen Eyrie, Pikeview station, Edgerton, and Rosemont, Colo., were not permanently marked.

ARIZONA.

TUCSON MAGNETIC OBSERVATORY.

[F. P. ULRICH, July 1, 1917, to Mar. 27, 1918; H. E. MCCOMB, Mar. 28, 1918, to June 30, 1918.]

At the Tucson Magnetic Observatory the usual observations were recorded.

The magnetograph recording variations in declination and horizontal intensity and vertical intensity was in continuous operation with the exception of short breaks that occurred on November 10 and 13 in adjusting the instruments. Scale-value observations were made at least once a month, and more often when made necessary by instrumental adjustments. Absolute observations were made usually twice each week.

Chronometer corrections were obtained from telegraphic time signals at Tucson by telephone until November and then by comparison of chronometers.

Both components of the Bosch-Omori seismograph were kept in continuous operation except during November and the first part of December, when the driving clock of the E-W component was sent to the office for repairs. Thirty-three earthquake shocks were recorded.

The usual meteorological observations were made.

Special magnetic observations were made from noon until 6 p. m. on June 8, at the time of the total solar eclipse.

In May, 1918, six complete sets of declination and horizontal intensity observations were made with magnetometer No. 40 for the purpose of making comparisons between the instruments here and at other observatories.

IOWA, KANSAS, AND MISSOURI.

[W. M. HILL.]

STATIONS OCCUPIED.—Iowa: Cascade, Clinton,* Columbus Junction, Davis City, Dewitt, Farley, Green Island, Humeston, Lamotte, Lineville, Mediapolis, Monmouth, Oxford Junction, Princeton, Tipton,* Stanwood, Wapello,* West Liberty, Wheatland, and Wilton Junction. Kansas: Herington. Missouri: Bethany, Bucklin, Kingston, Kirksville, Lawson, Linneus, Princeton, Trenton and Unionville.

Between July 1 and October 5, 1917, the three magnetic elements were determined at the places named. Old stations were reoccupied at the places marked by an asterisk (*).

Auxiliary stations were occupied as follows: Six in the vicinity of Salina, Kans.; 9 in the vicinity of Wapello, Iowa; 4 in the vicinity of Tipton, Iowa; and 3 in the vicinity of Clinton, Iowa.

A meridian line was established at Unionville, Mo.

At many of the stations permanent marks were not required, since they were in thinly populated regions, where the results obtained were mainly for the purpose of developing local magnetic disturbances.

ILLINOIS AND WISCONSIN.

[W. W. MERRYMON.]

STATIONS OCCUPIED.—Illinois: Chatsworth, Rochelle, Rockford, and Streator. Wisconsin: Delavan and 6 auxiliary stations, Drummond,† Eland, Fairchild, Hudson* and 6 auxiliary stations, Hudson (new station), Marengo,† Mercer,† Milwaukee, Mondovi, Moore,† New London, Pecks station* and 5 auxiliary stations, Port Washington* and 5 auxiliary stations, Rhinclander* and 4 auxiliary stations, Spooner and 8 auxiliary stations, Valley Junction, West Bend* and 4 auxiliary stations, Woodruff, and Woodville.

Between July 1 and November 10, 1917, observations of the three magnetic elements were made at the places named. Stations marked with an asterisk (*) were old stations reoccupied; those marked with a dagger (†) were new stations occupied but not permanently marked. Others were new stations established and permanently marked.

During the season a number of applications for magnetic data were received and forwarded to the office.

ALASKA.

[L. O. COLBERT.]

SUMMARY OF RESULTS.—Triangulation: 72 square miles of area covered, 9 stations in main scheme occupied for horizontal measures, 1 station in supplemental scheme occupied for horizontal measures, 35 geographic positions determined. Leveling: 0.2 mile of levels run. Topography: 14.9 square miles of area surveyed, 98 miles of general coast line surveyed, 0.2 mile of roads surveyed, 2 topographic sheets finished, scale 1:20,000. Hydrography: 73.7 square miles of area dragged, 1,768 positions determined (double angles), 77 retained soundings, 3 hydrographic sheets finished, scale 1:20,000.

Wire-drag party No. 4 began work in Alaska on May 3, 1917, and the work done to June 30 is reported in the annual report for 1917.

The location of the work was in Stephens Passage, Lynn Canal, and the two straits which connect those bodies of water, namely, Favorite Channel and Saginaw Channel. The northern limit extends across Lynn Canal from Point Bridget to the opposite shore. The eastern limit follows closely the indentations of the shore line, and is close to low-water mark in most places. In Lynn Canal the western limit is marked by a line from Point Whidbey to Little Island; in Saginaw Channel by a line between Point Retreat and Hump Island and also by the shore line of Lincoln and Admiralty Islands. The water areas within the above limits were completed as far south as Young Point. In addition a dragged strip three-fourths of a mile wide extends in mid-channel about 7 miles farther southeastward.

The hydrography consisted of a wire-drag examination of the area outlined above. The effective depth dragged was 85 feet at mean lower low water, except where less water was known to exist, as shown by previous surveys. When dragging close inshore no attempt was made to maintain this depth on account of the great loss of time, without adequate return, which would have been involved. Instead a depth of 45 feet was usually set as a maximum.

During the season 19 shoals with depths of 10 fathoms or less were located by the drag. Only one shoal in the track of steamers and dangerous to navigation was found. A number of soundings were secured in mid-channel where the depths were less than those shown on the chart, but these spots were not less than 10 fathoms in depth.

In addition to the above shoals a number of uncharted rocks and reefs lying close inshore were found either by the topographic party or by a launch party on a special investigation of suspicious localities where submerged rocks were reported by local fishermen. These rocks were located in the narrow strip which was left between the dragged area and the high-water mark on the beaches. Many of them were in the path of launches and cannery tenders, but out of the track of larger vessels.

Tides were recorded by an automatic gauge at Auke Bay, and an almost continuous record was obtained from May 15 to September 11.

Topographic surveys were made of the shore line contiguous to the dragged areas. On the mainland the shore line only was delineated in order to show several of the off-lying rocks and reefs not shown on previous charts or geological maps. The limits of the shore line surveys are a point opposite North Island on the north and the end of the peninsula extending into Fritz Cove on the south.

The western shore line of Douglas Island from Fritz Cove to a point $5\frac{1}{2}$ miles southeast of Point Hilda was surveyed. On the west side of Stephens Passage a survey was made of the shore line of Admiralty Island from Horse Island to Point Retreat, including the shore line in Barlow Cove and the smaller islands adjacent to this stretch. The entire shore line of Shelter and Lincoln Islands was run. All of the smaller islands lying within the limits of the above work were included in the topographic survey.

The control for the main part of this work was furnished by the primary triangulation party under F. S. Borden. A tertiary scheme was observed in advance of this work, when the progress of the drag preceded the observations of that party. It was necessary to run a tertiary scheme into Saginaw Channel for the determination of the signals in that channel.

The chartered steamer *Roscoe* and the launch *Wanick* were used in this work.

Field work was closed for the season on September 11, and the party returned to Seattle.

[A. JOACHIMS.]

SUMMARY OF RESULTS.—Triangulation: 7.7 square miles of area covered, 23 signal poles erected, 13 stations in main scheme occupied for horizontal measures, 3 stations occupied for vertical measures, 6 geographic positions determined. Topography: 126.25 square miles of area surveyed, 188 miles of general shore line surveyed, 2.9 miles of shore line of creeks surveyed, 6 topographic sheets finished, scale 1:20,000. Hydrography (wire drag): 216.2 square miles of area dragged, 1 tide station established, 3 current stations established, 5 hydrographic sheets finished, scale 1:20,000.

Progress made by wire-drag party No. 3 in the survey of Frederick Sound, Alaska, to June 30, 1917, was stated in the last annual report.

By the close of the season, September 28, 1917, the main ship channel of Frederick Sound had been dragged within the limits defined below, and the topography had been carried through the whole of the region covered by the drag. Two separate schemes of triangulation were run in order to establish the necessary control. Lines of soundings were run in the vicinity of buoys 17 and 24 and buoys 19 and 26 in Wrangell Strait in order to determine whether or not shoaling had taken place since the last survey in 1910. Tides were observed at Petersburg and Cleveland Passage, with an automatic tide gauge at the former place and by observers during 36 consecutive hours at the latter place. Current observations were taken at three current stations in the main ship channel, and additional notes were taken during the course of other operations. Coast-pilot notes were taken during the entire season. A topographic reconnaissance was made in the vicinity of Patterson Bay, Baranof Island.

The area dragged in Frederick Sound is bounded by Mitkof and Kupreanof Islands and Dry Strait on the south, approximately by a line from Port Houghton through the Sail Islands and the mainland on the north and by the mainland on the east. This area was completely dragged, except that the sudden ending of the season's work prevented certain small areas from being completed.

As much topography was done as was possible without interfering with the drag work. Current observations were made at three stations, one in mid-channel south of Cape Fanshaw, one in mid-channel between Portage and Farragut Bays, and one in mid-channel near the entrance to Thomas Bay.

Two schemes of tertiary triangulation were run in order to obtain the necessary control. At current stations and at various times while running to and from anchorages, cuts to mountain peaks were taken in order to aid in contouring the topographic sheets.

A tide staff was erected in Cleveland Passage, and tidal observations were taken during 36 consecutive hours.

An effective depth of 85 feet was dragged in most cases, except close inshore and over known shoals, where the prevailing depths were less.

The first trials with the drag at that depth were necessarily experimental, because this was the first occasion of such deep dragging. The metal floats in the equipment were designed to withstand the hydrostatic pressure at a depth of 72 feet, but they were not wholly satisfactory when used at the increased depth. The increased pressure caused a number of the floats to collapse the first time the drag was set out. Accordingly wooden floats were used during the greater part of the season.

The maximum length of a section permissible was found to be 400 feet with the type of buoys used. Long drags ranging from 10,000 to 12,000 feet in length were used, with both launches taking independent positions. For inshore work a somewhat shorter drag sufficed, although in this case also independent positions were taken. To insure an effective depth of 85 feet at all stages of tide, the length of the upright had to be 100 feet. In order to increase the buoyancy of the drag so as to guard against its sinking, two large buoys were substituted for two of the small buoys, one midway between the near and middle buoys and one midway between the middle and far buoys.

The chief difficulties encountered were due to tidal currents and floating glacial ice.

The entire area dragged during the season from April 27 to September 28 was slightly in excess of 400 square miles. This area was covered by five sheets, slightly overlapping.

On sheet 4, from Cape Fanshaw to the north end of Whitney Island, a small area remains unfinished.

The survey of the shore line on the south side of Frederick Sound is complete from a point about 3 miles southeast of Cosmos Point, near Dry Strait, to a point approximately south of Point Fanshaw. A little more than half of the shore line on either side of Portage Bay was run. The survey of the shore line on the north side of Frederick Sound is complete from the entrance to LeConte Bay, near Dry Strait, to Point Houghton, except for about 1.5 miles in the vicinity of Brown Cove. No attempt was made to survey Thomas Bay, and in Farragut Bay only those portions close to Frederick Sound were run. The Sukoi Islands, the Five Fingers, and the Brothers were run in, as well as other small islands. About one day's work was done in the vicinity of False Point Pybus.

Particular attention was paid by the topographers to the delineation of the low-water line, offshore rocks, and the kelp line, as well as to the high-water line.

Ten shoals, with depths varying from 43 to 85 feet, were located and reported during the season.

The immediate control for the greater part of the wire-drag hydrography and the topography was furnished by two separate small schemes of tertiary triangulation developed in advance of the other work. The first scheme extends from the Sukoi Islands to Portage and Farragut Bays. A subordinate scheme was extended from the above scheme into Farragut Bay for plane-table control.

The second scheme is in the vicinity of the Five Finger and Brother Islands.

The chartered launches *Equator*, *Roosevelt*, and *Freyea* were used in this work.

Lines of soundings were run in the vicinity of buoys 17 and 24, at the entrance to Wrangell Strait, to determine whether or not shoaling had taken place, as reported, since the survey of 1910. Similar lines were run at buoys 19 and 26 for the same purpose. No material difference was found when the results were compared with the chart.

Before dragging operations were begun an automatic tide gauge was installed at the end of the old unused sawmill dock at Petersburg. Continuous records were obtained from April 25 to September 28. Lines of leveling were run connecting the tide gauge with previously established bench marks.

A tide staff was erected at an unused dock in Cleveland Passage. Observations were taken during 36 consecutive hours. Lines of level were run from a recovered tidal bench mark on Whitney Island.

An effort was made during the season to obtain as much current data in Frederick Sound as was practicable without interfering with the drag work. In addition to the three current stations established and the data taken therefrom, notes were taken at various times during other operations.

In accordance with instructions a subparty was sent out to determine the heights of Mount Cecil and Mount Elizabeth, which are on the east side of Baranof Island, just north of Patterson Bay, and to determine whether or not there were any lakes of considerable size in the same vicinity.

Three triangulation stations were recovered, and directions and vertical angles were observed on the principal peaks in the vicinity of Mount Cecil and Mount Elizabeth. From these observations the geographic positions and the heights of Mount Cecil and Mount Elizabeth were computed.

In order to determine whether or not there was a large body of fresh water in the vicinity of the above-mentioned peaks, an attempt was made to climb one of the ridges near the head of Patterson Bay. At the elevation reached one lake could be seen across the valley at the head of the bay. The height of this lake above sea level was determined approximately. Another lake was discovered at the head of a stream flowing into the upper part of the bay.

Coast-pilot notes were gathered in regard to all important localities visited.

[FRANK S. BORDEN.]

SUMMARY OF RESULTS.—Triangulation: 55 square miles of area covered, length of scheme 25 miles, 23 signal poles erected, 22 stations in main scheme occupied for horizontal measures, 22 geographic positions determined.

At the beginning of the fiscal year work was in progress on a scheme of primary triangulation in Stephens Passage, southeastern Alaska, to extend south-eastward from the vicinity of Lincoln Island to Grand Island.

The object of this triangulation was to furnish control for a wire-drag party operating in this locality, and also to establish a strong scheme of triangulation through this section of southeastern Alaska.

Previous to June 30 the triangulation had been carried from Young Bay northward to the line Sentinel-Little on Sentinel and Little Islands in Lynn Canal.

Work was then taken up in Young Bay. A base line was measured at the head of Young Bay, after which the triangulation was carried southeastward. Work was closed for the season on September 25, the triangulation at that time having been carried to a base, Rock-Grave, 2 miles south of Grand Island. From the main-scheme stations of the triangulation, all banners, whitewashed rocks, etc., established by the wire-drag parties, were cut in, as well as many prominent peaks, lighthouses, etc.

Two subsidiary stations, Marmion and Entrance, were established at the entrance to Gastimeau Channel as a base for carrying the triangulation up the channel. The positions of these stations were computed through the quadrilateral Corner, Oliver, Marmion and Entrance. The stations Corner and Oliver are main-scheme stations. The subsidiary stations Marmion and Entrance were occupied.

From the base Sentinel-Little, the north end of the season's work, the lines are clear to the next pair of stations northward, while from Rock-Grave, the south end of the work, the lines are clear to Lime-Stone, the next pair of stations southward. Signals Lime, Rock, and South had been built, and were ready for occupation at the close of the season.

[E. W. EICKELBERG.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 48 miles, 172 square miles of area covered, 49 lines of intervisibility determined, 23 points selected for scheme. Base lines: 1 primary, 4,800 meters in length. Triangulation: Length of completed scheme 80 miles, 92 square miles of area covered, 18 signal poles erected, 1 observing tripod and scaffold built (height 20 feet), 15 stations in main scheme occupied for horizontal measures, 1 station in supplemental scheme occupied for horizontal measures, 4 stations occupied for vertical measures, 25 geographic positions determined, 4 positions determined trigonometrically.

The party engaged in the primary triangulation of Frederick Sound, southeastern Alaska, was in the field at the beginning of the fiscal year. Progress made to July 1 is reported in the annual report for 1917.

The primary object of this work was to furnish control for the wire-drag party operating in Frederick Sound.

The launch *Marguerite* was chartered for the use of the party.

On account of numerous rounding points and also to peculiar turns in the channel, the reconnaissance had to be very thorough before any signal building could be done. In some cases mountain peaks might have been used to advantage, but would have caused considerable delay on account of rain and overhanging clouds.

It was at first thought from previous experience that the observations would be made in the daytime, but it was found that the necessary accuracy could not be obtained by sighting on the signals, and both carbide and electric lights were used, the latter proving most satisfactory.

The signals consisted of a tripod with center pole. The signal was used mainly as a day mark for the wire-drag parties and for sighting on before the lights or heliotropes were showing.

The instrument support and light stand consisted of a four-legged stand, suitably braced and weighted down with stones, or cemented to the rock. A platform for the observer was built around the stand. At Turnabout Island a 50-foot scaffold had to be built and at North Base it was necessary to build a 20-foot scaffold.

A base line was located on the same ground as the old base of 1887, except that it lay farther inshore on ground above high water and was much shorter. No ready method presented itself for connecting with the main scheme from this base, and the question of getting by Point Agassiz and the Sukoi Islands without considerable overlapping of figures presented a difficult problem.

A site was found where by clearing about 500 yards of woods and utilizing a beach which bares at low water the base was made a main-scheme line so as to overcome the difficulty mentioned. The base is 4,800 meters in length.

At the close of the season 20 miles of triangulation remained to be done to connect with the work of 1916 in Dry Strait. Signals Creek, Bluff, Pershing, and Camp had been erected, when orders were received to close work, and owing to unfavorable weather in the latter half of September were not occupied. Work was closed for the season on September 25.

REPORT OF SUPERINTENDENT, COAST AND GEODETIC SURVEY. 745

[T. J. MAHER, Commanding Steamer *Explorer*.]

SUMMARY OF RESULTS.—Topography: 10.5 miles of shore line surveyed. Hydrography: 8.8 square miles of area covered, 133.4 miles run while sounding, 1,137 positions determined (double angles), 1,239 soundings made, 1 tide station established.

At the beginning of the fiscal year the steamer *Explorer* was engaged in general surveys on the outer coast of southeastern Alaska northward of Cape Muzon. The work of the party was seriously handicapped by the desertion of a number of the crew and the resignation of the chief engineer.

Owing to these hindrances to field work the commanding officer was ordered by telegraph on July 12 to close work, transfer the steamer *Cosmos*, launch 117, and certain officers and men to the *Patterson*, and return with the *Explorer* to Seattle. The vessel arrived at Seattle August 19.

[C. G. GUILLIAN, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Triangulation: 83 square miles of area covered, 139 signals erected, 48 stations in main scheme occupied for horizontal measures, 3 stations in supplemental scheme occupied for horizontal measures, 62 geographic positions determined. Magnetic work: 2 land stations occupied for magnetic declination. Topography: 32 square miles of area surveyed, 71 miles of coast line surveyed, 4 topographic sheets finished, scale 1:20,000. Hydrography: 42 square miles of area covered (inshore), 2,275 square miles of area covered (offshore), 976 miles run while sounding, 3,850 positions determined (double angles), 8,092 soundings made, 3 tidal stations established, 1 current station established, 4 hydrographic sheets finished, scales one 1:200,000, two 1:20,000, and one 1:10,000.

At the beginning of the fiscal year the steamer *Patterson* was engaged in general surveys in the approaches to Cross Sound, including Lisianski Inlet and Strait, Alaska. Progress to June 30, 1917, is detailed in the last annual report.

By that date the triangulation had been completed from Cross Sound to below Stag Bay and signals built to Point Urey. Reconnoissance had been made and some of the signals built for several figures into Lisianski Inlet below Junction Island, and the topography completed to Stag Bay. No offshore soundings had been made, but the hydrography of the narrow portions of Lisianski Strait had been completed for the use of the *Patterson*, and in anticipation of vessels being sent to the cannery under construction in Stag Bay.

Work was continued after July 1, 1917, the vessel sounding outside and offshore on favorable days. These soundings will be useful on the charts, although the work was not completed. Soundings were made only when points on shore were visible for determining the position of the vessel. For continuing this work peaks are located or available along the Yakobi and Chichagof shores.

Inshore the triangulation was extended to the head of Lisianski Inlet, through Lisianski Strait, and thence southward to Khaz Bay, where a connection was made with the work of E. F. Dickins, 1906. Further observations are desired in this triangulation.

The topography and hydrography of Lisianski Inlet and Strait were completed. No work was done on the west shore of Yakobi Island.

A topographic survey of the vicinity of Nickel was made, and a hydrographic reconnoissance of the approach also made. The topographic survey does not join the Lisianski Strait work by about 2 miles, and there is a larger gap between the hydrographic work off Nickel and the entrance of Lisianski Strait.

The *Cosmos* and crew were assigned to the *Patterson* from the *Explorer* on August 1, and the addition of this launch, on which the party could live, made possible the connection of the triangulation with Khaz Bay and the topographic work in vicinity of Nickel.

The west coast of Yakobi Island and Chichagof Island are extremely irregular and foul, and a vessel of any size or draft can not approach the shores. There are numerous small bays and inlets into which small gas launches can find shelter. Many of these have only a few feet at low water and contracted entrances. Nickel, for example, is in a small bay called Mirror Harbor, which is landlocked. The approach is narrow and foul, and at the narrowest point, about 20 yards wide, are two rocks, and a sharp turn must be made. It was all the *Cosmos* could do to make this shelter.

On September 20 orders were received to close work at once, store the outfit, and return to Seattle. The camp party was picked up September 22 and the party proceeded to Juneau.

From Juneau the *Patterson* proceeded to Metlakatla, having to anchor over several days because of too heavy weather to tow the *Delta*. Both the *Delta* and *Cosmos* were sent by way of Zimovia Strait and Ernest Sound from Wrangell Narrows.

At Ketchikan the power-boat equipment of wire-drag party No. 3 was taken aboard, and the vessel then proceeded to Metlakatla. At Metlakatla the various boats were stored. The ship left Metlakatla on October 8, obtained mail and provisions at Ketchikan, and sailed for Seattle at midnight, reaching Seattle October 13.

As a number of the officers had been transferred to the Army and Navy, and all Army officers had orders detaching them on arrival, these officers continued office work on sheets and records until detached, and completed the inking of the topographic sheets.

On October 16 three of the officers left under orders to report at Fort Monroe for Army duty. The same day the *Patterson* was taken into Lake Union through the Lake Washington Canal and Locks and moored at the county dock built for the Survey.

Three additional officers were enrolled in the United States Naval Reserve Force on October 15, and directed to continue duty on the *Patterson*, pending orders from the Bureau of Navigation. The commanding officer and one other officer were not enrolled until the end of the year and also continued on duty on board the vessel. On enrollment they were assigned to continue duty on the *Patterson*, pending orders of the Bureau of Navigation.

During the season the following work was accomplished: The triangulation control was extended through Lisianski Inlet, Lisianski Strait, and southward along Chichagof Island to Khaz Bay, thus connecting Cross Sound triangulation, by J. F. Pratt, 1901, with Khaz Bay triangulation, by E. F. Dickens, 1905. Triangulation was also extended to the head of Lisianski Inlet.

The topographic survey covered all of Lisianski Inlet, Lisianski Strait, and Stag Bay. The control was furnished by triangulation above mentioned. Topography covered contours of hills adjacent to the shore line. The topographic survey extends southward to Ilin Bay, then there is a gap of about 2 miles, and then a further topographic survey in the vicinity of Nickel and the northern part of Portlock Harbor.

A complete hydrographic survey was made of Lisianski Inlet and Lisianski Strait, a hydrographic reconnaissance of Davison Bay, and the hydrographic offshore development extends 27 miles offshore and 60 miles along the coast.

[E. E. SMITH, Commanding Steamer *Taku*.]

SUMMARY OF RESULTS.—Triangulation: 54 square miles of area covered, 13 signal poles erected, 13 stations in main scheme occupied for horizontal measures, 11 geographic positions determined. Leveling: 3 permanent bench marks established. Magnetic work: 1 land station occupied for magnetic declination. Topography: 40 square miles of area surveyed, 478 miles of general coast line surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 32 square miles of area covered, 163 miles run while sounding, 818 positions determined (double angles), 1,328 soundings made, 1 tide station established, 1 hydrographic sheet finished, scale 1:20,000.

The party for the steamer *Taku*, under instructions to continue the survey of Prince William Sound, arrived at Cordova on May 10, and was employed until the end of June in making needed repairs to the vessel.

On July 7 the vessel proceeded to Port Nellie Juan, arriving on July 8, and the next day began building signals.

The engines and boiler of the *Taku* were in bad condition and even after being repaired were constantly breaking down. An engine which had been ordered for launch No. 39 did not arrive in time to be of service, and was not installed.

The signal building, observing and topographic parties were obliged to go to work and return in pulling boats.

The cannery of the Copper River Packing Co. in the small bay on the east side of McClure Bay gave the use of their dock as a berth for the *Taku* and supplied water and storage for coal without charge.

A storehouse for the Survey was built at the head of the bay where the cannery is situated.

An automatic tide gauge was set up at the cannery dock, and bench marks were established. The greatest range observed was 16.9 feet.

No current observations were made, as there were no facilities for anchoring in the deeper parts of the channel. The currents appear to set with the channels and are usually weak, not exceeding probably from one-fourth to three-fourths knot in Port Nellie Juan.

The triangulation was extended from the base First-Catch, the most available line. Thence three quadrilaterals were extended through the first reach of Port Nellie Juan.

The topography was extended from the triangulation stations Wire and End at the entrance to Port Nellie Juan through the first reach to the turn at stations Land and Fini, including McClure Bay. The work was done with the plane table, a traverse being run from station Port down the east side of McClure Bay and thence to station Land. The remainder of the shore line and the contours were done after the triangulation was completed. The woods covering the lower slopes dwindle away at about the thousand-foot curve. Soundings were made over the area of McClure Bay and the outer reach of Port Nellie Juan.

Observations for magnetic deviation were made with the compass-declinometer at station Port.

At the request of the mayor of Cordova a military registration of eligibles for the draft was made by the chief of party at Port Nellie Juan.

Field work was closed for the season on August 22, and the party arrived at Seattle September 5.

At Cordova the *Taku* was inspected by officers of the Steamboat-Inspection Service, who recommended that she be condemned and sold.

The equipment to be retained for use was stored at Cordova, and the instruments were shipped to Seattle.

The chart agency at Cordova was inspected while the vessel was being held up, and a member of the party was sent to inspect the agency at Valdez.

[E. R. HAND.]

SUMMARY OF RESULTS.—Leveling: 3 miles of levels run, 4 permanent bench marks established. Topography: 2 square miles of area surveyed, 10 miles of coast line surveyed, 5 miles of roads surveyed, 1 topographic sheet finished, scale 1:10,000. Hydrography: 15 square miles of area covered, 151 miles run while sounding, 1,200 positions determined (double angles), 2,140 soundings made, 1 tide station established, 1 hydrographic sheet finished, scale 1:10,000. Wire-drag work: 14 square miles of area dragged, 3.5 linear miles dragged, 466 angles measured.

Preparations were made and a party organized at Seattle, Wash., in March and April, 1918, for wire-drag work at Knik Harbor, Anchorage, Alaska, and on April 21 the party sailed for Alaska on the S. S. *Admiral Farragut*.

On the way up the *Farragut* struck an obstruction in Wrangell Narrows, but was able to proceed to Juneau, where the freight was landed and the passengers and mail transshipped to the *Alameda*, which landed the party at Anchorage on May 3, but without gear or instruments, which were not received until May 17. The intervening time was spent in building signals, erecting a tide gauge, arranging for the necessary boats, and other preparatory operations.

The work contemplated by the instructions included a wire-drag survey of Knik Arm between Point Woronzof and Cairn Point, with wire-drag set at an effective depth of not less than 40 feet at mean lower low water, and to within 3 feet of the bottom at less depth, and on all separate or detached shoals of less than 40 feet depth the minimum depth to be determined. It was also directed that a hydrographic survey with lines 200 meters apart and a closer development where needed be made over the same area.

An automatic tide gauge was put in operation June 1, four permanent bench marks were established and connected by leveling with each other with the staff and with a bench of 1914.

A topographic revision was made in order to show certain improvements. Hydrographic signals were located with the plane table, and the rocks seen at lowest tides were cut in. The only ones considered dangerous were found off Cairn Point.

Triangulation stations at points Woronzof and Mackenzle were found in danger of slipping over the bluff and so were re-marked with bronze plates in concrete, set farther back, and in such a way as to preserve the azimuth of the line.

The entire harbor from Cairn Point to Point Woronzof was sounded, and the greater part of the navigable area was dragged. This work, which was not completed, was in progress at the close of the fiscal year.

The work of sounding was accomplished under unusual difficulties. There is an extreme tidal range of 40 feet, and in consequence the tidal currents are very strong, attaining at times a velocity of almost 7 knots.

For this reason it was impossible to run lines crosswise of the channels, and the following plan was adopted: Out to about 10 fathoms the lines were run normal to shore, and beyond that they were run lengthwise of the Arm. Advantage was taken of slack water for the first, but when the current set in, lines were run with it the length of the harbor.

Inshore there was found mud bottom of even slope, but a short distance outside of the low water the bottom drops off abruptly and the lead develops great inequalities, showing deep holes and all rocky, with traces here and there of clean sand. The strong currents continually scouring out the bottom cause the silt brought down from the upper Arm to be held in suspension until it reaches the shoals just outside the points.

The drag work in deep water was quickly finished, but when it became necessary to operate the drag close to the bottom, much difficulty was experienced, owing to the irregular bottom and the strong currents. It was impossible to operate the drag, except about the time of slack water and by drifting with the current.

A number of shoal spots surrounded by deeper water was found, but it was impossible to decide whether they were menaces to navigation until the least depths over them were more accurately determined.

Launches for the sounding and wire drag were furnished by the Alaskan Engineering Commission, which otherwise cooperated in the work in every way practicable.

[A. J. ELA, Commanding Steamer *Yukon*.]

In June, 1917, a party was organized at Seattle for work during the summer season of 1917 on the south coast of the Alaska Peninsula.

The party left Seattle July 10 and arrived at King Cove, Alaska, July 20.

On July 24 and 27 orders were issued directing the chief of party to repair the steamer *Yukon* and return to Seattle as soon as practicable, without attempting to do any field work. As it was apparent from the first that it was impossible to get the *Yukon* in commission in time to do any field work during the season, it had been determined to repair the launch *Alpha* and do field work with her when the weather conditions were favorable, reserving for less favorable weather the completion of the repairs to the *Yukon*.

At the time the instructions to return to Seattle were received the repairs to the *Alpha* were nearly completed, but the *Yukon* had been taken apart and the material which it was thought could be used again was piled up under canvas on the ground around her. It was impossible to replace this material in time to have taken the September mail boat to Seattle, but an extra effort was made to get the better part of it back in time to take the mail boat on its October trip, a carpenter and helper being left to complete the replacing of some of the interior woodwork and to attempt to complete the new pilot house. Toward the close of the season the vessel was entirely roofed over as a protection from the elements.

No survey work was done during the season other than a hasty reconnoissance of Morzhovoi Bay and the establishment and operation of an automatic tide gauge at King Cove from July 31 to October 17, 1917.

[J. W. GREEN.]

STATIONS OCCUPIED.—Alaska Eagle and Circle.

Between June 16 and 30 observations of the three magnetic elements were made at the above-named stations on the Yukon River, in the interior of Alaska, small boats being used for transportation between stations.

Before leaving Sitka the instruments were compared with the absolute instruments at that observatory.

SITKA MAGNETIC OBSERVATORY.

[J. W. GREEN, July 1, 1917, to June 9, 1918; F. P. ULBICH, June 10, 1918, to June 30, 1918.]

The usual observations were recorded at the Sitka Magnetic Observatory during the year with practically no interruption.

The magnetic variation instruments have continued in satisfactory operation.

Absolute observations, consisting of three sets of declination, two sets of dip, and the regular double set of horizontal intensity observations, were obtained twice each week, with the exception of one week in October, when the absolute observation building was being moved to a new site.

Time observations from noon transits of the sun were obtained when practicable.

The seismograph was kept in operation and a total of 21 earthquakes, nearly all of small magnitude, were recorded during the year. During April and May the record was partly interrupted, owing to the failure of the driving clock.

Immediately after securing the absolute observations on October 1 the work of moving the absolute-observation building from the Swanson property to the new site was begun. This work occupied two weeks. From the new site the former azimuth mark is not visible, and consequently it was necessary to transfer the azimuth and use a new mark. Comparative observations were made to determine the relation between the old and the new sites.

PORTO RICO.

[F. L. ADAMS, July 1, 1917, to Apr. 12, 1918; WALLACE M. HILL, Apr. 13 to June 30, 1918.]

At the magnetic observatory at Vieques, P. R., the usual absolute observations of the three magnetic elements—declination, dip, and horizontal intensity—were made.

The magnetograph and seismograph have been in practically continuous operation. Twenty-eight earthquakes were recorded during the year.

The buildings at the station are in good condition of repair.

About 2 acres of waste land surrounding the station were cultivated, and a fair crop of corn, beans, sweet potatoes, and other vegetables was raised.

VIRGIN ISLANDS.

[O. W. SWAINSON.]

SUMMARY OF RESULTS.—Reconnaissance: 5 lines of intervisibility determined, 2 points selected for scheme. Base lines: 1 secondary 1,848.38 meters in length. Triangulation: 198 square miles of area covered, 98 signal poles erected, 3 observing scaffolds and tripods built (heights 30 to 40 feet), 15 stations in main scheme occupied for horizontal measures, 7 stations in supplemental scheme occupied for horizontal measures, 18 stations occupied for vertical measures, 68 geographic positions determined, 8 elevations determined trigonometrically. Leveling: 2 miles of levels run. Topography: 10 square miles of area surveyed, 37.5 miles of general coast line surveyed, 1 mile of shore line of ponds surveyed, 18 miles of roads surveyed, 1 topographic sheet finished, scales 1:900 and 1:10,000.

In January, 1918, a party was organized for surveys in the Virgin Islands. This party left New York for San Juan, P. R., on February 2, arriving at San Juan on February 7. While waiting for transportation to St. Thomas a search was made for launches suitable for wire-drag work.

The party arrived in Charlotte Amalie, St. Thomas, on February 19, and the chief of party immediately reported to the governor of the islands. With the assistance of the Engineering and Pay Departments of the Navy on the following day, the party was organized and bids for supplies sent out.

A site for a base line was selected, and, as soon as the supplies were received and the party organized, work was begun on it. A subparty was put to work building signals.

The best site for a base line was found to be 1 mile east of the town, starting on a small knoll just east of the West Indian Co.'s Dock and running in a northeasterly direction to the base of the hills. The base site rose gradually on an average of 2½ per cent after a steep decline of a 16 per cent slope in getting away from south base. North base was 103 feet higher than south base, the elevation of the lowest stake being 40 feet lower than either base. The length of the base was 1,848.3865 meters.

Four by 4 inch stakes were driven 25 meters apart and lined in with a theodolite. Brass strips were fastened on top of the stakes on which the zeros of the tape fell. The elevation of the top of the stakes was determined with a wye level. A standardized invar tape was used for measuring. The regular method of base measurement with the use of this type of tape was employed.

The triangulation was carried from the established line East End on Vieques Island, Savana. Heliotropes were used on both ends of the three lines from East End. Three parties, one in charge of each officer, were in continuous operation.

It was necessary to build a tower at East End in order to see Buck Island. The height of this tower was computed, and accordingly enough lumber was taken there from Fajardo for the purpose. Buck Island Light could be seen from the top of this tower at night, but the heliotrope could not be seen in the daytime, although of equal elevation. It was necessary to build a tower alongside of Buck Island Light and 15 feet higher to overcome the difficulty.

Central-point figures were decided upon to give the best bases for cutting in topographic control stations with the least amount of main-scheme observing. Intersection stations were established about every mile along the shore line for

topographic control. These were cut in from at least three stations wherever possible. The triangulation was rushed in order to get one topographic party started on the most difficult topographic sheet.

One topographic party was started on the sheet embracing the town and harbor on April 22. The other party was started on the western sheet May 1. Both continued with only short interruptions for signal building and triangulation the balance of the fiscal year.

Extreme care was taken to obtain accuracy on the sheet covering the town. An elaborate control was furnished. The contours were determined with more than ordinary precision, due to the fact that the local government is contemplating installing a water system in the vicinity, and the Coast Survey chart would be studied for a waterworks site.

At the request of the Navy Department particular stress was given the locating of old ruins, stone walls, boundary monuments, etc. All of this topography was done on a 1:10,000 scale. Twenty-foot contours were determined.

At the request of the local authorities a special topographic survey was made of a piece of alien property which it was contemplated to seize for military purposes. This survey consisted in locating the shore line, docks, houses, and contours. It was on a scale of approximately 1:900. Assistance was rendered the naval civil engineer by checking his results in laying out the foundation for a wireless tower. The commanding officer of the Marines supplied a launch whenever it could be spared.

HAWAIIAN ISLANDS.

[FRANK NEUMANN.]

At the magnetic observatory near Honolulu a continuous record was obtained with the variation instruments.

Absolute observations were made weekly to determine base-line values. Scale-value observations were made monthly.

The Milne seismograph was in operation with only slight interruptions, and 107 earthquakes were recorded.

In order to obtain chronometer corrections, time observations with sextant and artificial horizon were made three or four times each month.

Meteorological observations were made as usual and reported monthly to the United States Weather Bureau office at Honolulu.

PHILIPPINE ISLANDS.

[FREMONT MORSE, Director of Coast Surveys.]

The work of the Survey vessels was somewhat handicapped by the greatly increased cost of all supplies and particularly of coal. The difficulty in regard to coal was greatly relieved by the purchase from the Navy of a supply for the *Pathfinder* and *Fathomer* at a cost of about half the prevailing local price.

In August when it became apparent that the Philippine appropriation was insufficient to meet the expenses of the surveying parties to the close of the year, a request was made to the Philippine Emergency Board for an allotment which was granted. Later it became necessary on account of the shortage of officers and delays in repairing to withdraw the *Fathomer* and *Research* from active service, so that the whole of the extra allowance was not needed, and a portion of it was returned to the insular treasury.

As it was not practicable to replace the officers sent back to the United States and those transferred to the Army and Navy the steamers *Research* and *Marinduque* were laid up and the *Research* was finally transferred back to the insular government.

On December 31 the steamer *Pathfinder* was taken to the Olongapo Naval Station for extensive repairs.

The Philippine Committee on Geographic Names was reorganized June, 1917, and, after a preliminary meeting on August 30, meetings were held monthly beginning on October 3. The names of barrios are being considered province by province, and good progress had been made.

The Harbor Line Commission was reorganized November 6, 1917, and the Director of Coast Surveys was continued as a member.

Extensive repairs to the steamer *Pathfinder* begun in December were greatly delayed by the pressure of Navy work at the Olongapo Naval Station, so that the ship did not get away from the yard until April 20.

The steamer *Marinduque* was temporarily turned over to the bureau of labor of the Philippine government on March 19, 1918.

OFFICE WORK.

In the computing division the office work on reductions of tides and soundings was carried on as usual. In the triangulation no main scheme adjustment was undertaken, as all work was on minor schemes in regions previously covered by main scheme adjustments. The computation of geodetic positions and the preparation of final abstracts of positions were prosecuted to such an extent that final positions are available for all stations in adjusted work throughout the Visayas and Northern Mindanao, except along the east coasts of Mindanao, Leyte, and Samar.

In the drafting and geographic divisions, 22 hydrographic and 9 topographic sheets, besides 2 supplemental hydrographic sheets and 1 supplemental topographic sheet, were received, making a total of 1,388 survey sheets received since the commencement of the surveys in the islands. The number of survey sheets on hand at the Manila office on December 31, 1917, was 399.

Seven chart tracings were completed and forwarded to Washington for printing, consisting of 3 new charts, 1 new edition, and 3 correction pieces. Seven chart drawings were in progress on December 31, 1917.

Tracings were made of 10 topographic and 3 hydrographic sheets.

The necessary field projections and other data were furnished to hydrographic parties and the regular plotting and verification of hydrographic sheets and inking of topographic sheets were attended to.

Blue prints of topographic sheets were furnished to other Bureaus and individuals.

A large progress map of work of the Coast and Geodetic Survey in the Philippine Islands was prepared for exhibit during the Philippine Carnival in February, 1918.

In the geographic division the tracings for the map of the Philippine Islands on a scale of 1:1,000,000, size 1.33 by 2.09 meters, were sent to the United States for publication. This map was constructed in accordance with the plans for a map of the earth on a uniform scale adopted by the International Geographic Congress.

Progress was made on drawings for five other maps of the Philippine Islands, viz: No. 50, Mindanao Island, scale 1:600,000; No. 13, Samar; No. 3, Northern Luzon, scale 1:200,000; No. 6, Central Luzon, Eastern Part, scale 1:200,000; No. 9, Southeastern Luzon, scale 1:200,000.

The sales of maps and blue prints were attended to by the chief clerk of the Manila suboffice.

A list of names of municipalities, barrios, and sitios is being compiled in the geographic division.

An alphabetical card index was begun to include all Philippine geographic names.

[H. C. DENSON Commanding Steamer *Pathfinder*.]

SUMMARY OF RESULTS.—Topography: 32.5 square miles of area surveyed, 54 miles of general coast line surveyed, 7.5 miles of rivers surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 1,058.4 square miles of area surveyed, 2,866.7 miles run while sounding, 6,939 positions determined (double angles), 21,755 soundings made, 1 tide station established, 4 hydrographic sheets finished, scales one 1:60,000 and three 1:20,000. Traverse: Length 25.1 miles, 8.1 square miles of area covered, 23 signal poles erected, 21 stations in main scheme occupied for horizontal measures, 16 stations in supplementary scheme occupied for horizontal measures, 21 geographic positions determined.

At the beginning of the fiscal year the steamer *Pathfinder* was engaged in the survey of the approaches to Burdeos Bay, Polillo Island.

The control for this work was obtained from supplementary tertiary triangulation from four recovered stations. Eight stations were occupied. Additional hydrographic signals were determined by plane-table cuts and traverses. Launch hydrography in this locality, which had been interrupted from June 28 to August 28, was completed September 28. The extremely irregular bottom necessitated lines at 100 meters intervals and very close development of important shoals and channels. As the bottom is visible in a good light at 5 fathoms, it is quite certain that the channels, where no indications of shoals were found, are quite clear.

As discrepancies were found in the shore line, the previous work in this locality done in 1908 was disregarded, and a complete examination was made.

The examination did not reveal any new dangers in the 1906 deep channel, though less water was found on most of the known shoals. A new deep chan-

nel was found north and east of Pacabalo Reef. A very complicated 9-fathom channel was developed between Polillo Island and Cataoyan Reef. Numerous rocks and shoals were found which practically close navigation for about 3 miles south of Patnanongan Island, to the eastward of Minasawa Island.

The work on the southern approaches to Burdeus Bay was interrupted at the end of June in order to take up work on an offshore hydrographic sheet extending some 24 miles north and east of Polillo and the Uala Islands and to survey the north coast of Polillo Island.

The area to the north of Polillo Island completed this season includes in addition to the offshore sheet a topographic and an inshore hydrographic sheet covering the unsurveyed north and northwest coasts of Polillo Island. Owing to flat thickly wooded ridges, triangulation was impracticable, and the control for the Polillo Island work was obtained by theodolite-stadia traverse around the north coasts between triangulation stations established in 1906 and 1916. This 24-mile traverse was made with due regard to accuracy and time, no sights in excess of 400 meters being taken, the distances across bays and rivers being obtained by triangulation and the distances checked by an improvised tape of stranded sounding wire whenever practicable. The closing error was 0.72 meter per mile of traverse, or 1:2,540.

The traverse was started in the second week in July and the topography and inshore hydrography completed by the third week in August. The coast line indicated on the existing chart was found to be considerably in error in appearance and 3 to 4 miles south or inside the true position.

An anchorage with gray mud bottom, about one-half square mile in area and protected in all directions except from the north, was found in Pinavisagan Bay, on the northeast coast of Polillo Island.

An excellent landlocked anchorage with depth of 3 fathoms mud bottom for small vessels with a swinging radius of 150 feet was found in the south bight of the Pinagagan River, on the northwest coast.

No ship watering places were found. The small surface streams are practically dry from May to October, and the rivers are salt for several miles from their mouths.

The signals used for offshore hydrography were, with but two exceptions, natural objects located by the few practicable triangulation directions and by sextant angles from the ship.

Work on the offshore sheet was commenced on June 27 and continued at intervals until it was completed on October 17. The only detached shoal indications found and developed were the 15-fathom banks lying about 5 miles northwest of Polillo Island and an 8-fathom spot about 4 miles east of Kalongkoon Island.

On the afternoon of October 17 and morning of October 18 the ship partially developed a shoal spot lying one-third mile east of the small islet which lies due north of the eastern end of Palasan Island. Further work is required in this locality, as it was impracticable to complete the development on account of heavy seas.

There is little remarkable in the appearance of the areas examined. The low islands in front of the higher wooded ridges of Polillo afford numerous natural ranges through the channels into Burdeus Bay, but since they usually consist of slight variations in the sky line over clumps of trees it is impracticable to so describe them in print as to preclude mistakes in identifying them.

The north coast of Polillo is thickly wooded with several flat-topped ridges, rising very gradually to a height of 690 feet. As the different ridges can be distinguished only in misty weather and from offshore, the contours which have been sketched may be very inaccurate. Except in the heads of the bays and in the rivers, the entire coast is fringed by a coral reef, which extends out for distances ranging from 100 meters to almost a mile from the high-water line. On the northwest side a small barrier reef extends about 2 miles offshore. There is only a complicated small-boat passage between it and the shore reef. Landing on the open coast in a heavy swell would be very dangerous. One of the numerous bays should be made if possible. Notwithstanding the protection of the reef, the high-water line exposed to the northeast everywhere shows evidence of strong wave action. The rock outcrops are always undercut and very irregular, while the coral sand is driven up in a dike from 15 to 20 feet high.

The commercial possibilities of this coast are limited, at least in the near future. There is no great amount of large accessible timber. The land is probably fertile, but it requires considerable labor to clear it. Coconuts and

other plants cultivated by the inhabitants do well. The present inhabitants consist of Tagalogs and a number of scattered families of Dumagats.

The season's work was brought to a close on October 18, and the *Pathfinder* proceeded to Manila, at which port the vessel arrived on October 22. From this date to December 1 the vessel was anchored in Manila Bay, the party being engaged in making out specifications for repairs to vessel and preparing field data to submit to the Manila office; also in preparing inventories, etc., necessary to effect transfer of command. From December 2 to December 31 the *Pathfinder* was undergoing repairs at the Olongapo Naval Station. On December 31 the command of the steamer *Pathfinder* was transferred from H. C. Denson to H. B. Campbell.

[A. M. SOBISRALSKI, Commanding Steamer *Pathfinder*.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 10 miles, 29 square miles of area covered, 5 lines of intervisibility determined, 2 points selected for scheme. Base line: 1 secondary, 4,706 meters in length. Triangulation: 52 square miles of area covered, 14 signal poles erected, 2 stations in main scheme and 3 stations in supplemental schemes occupied for horizontal measures, 2 stations occupied for vertical measures, 5 geographic positions determined, 2 elevations determined trigonometrically. Topography: 59.6 square miles of area surveyed, 58.5 miles of general coast line surveyed, 17.5 miles of shore line of rivers and creeks surveyed, 34 miles of roads surveyed, 8 topographic sheets finished, scale of topographic sheets 1:10,000 and 1:20,000. Hydrography: 305 square miles of area covered, 1,771.9 miles run while sounding, 5,820 positions determined (double angles), 25,210 soundings made, 2 tide stations established, 1 hydrographic sheet finished, scale of hydrographic sheets 1:20,000 and 1:40,000.

While repairs to the steamer *Pathfinder* were in progress at Olongapo, a detached party completed the survey of Mariveles Harbor. The topography was carefully rerun and a close development on a 1:10,000 made of the harbor.

The *Pathfinder* sailed from Manila for the working ground on the east coast of Palawan on May 7. En route a small patch of hydrography south of Dumarán Island was completed and some deep soundings off Bold Point were taken. Upon arrival at Puerto Princesa the final reconnaissance for the base line was made and a party left at Iwahig to prepare the base for measurement. On May 31 the base line was ready for measurement. The base line is only 4,700 meters long, but a good scheme of expansion makes it possible to use this length.

Besides the areas off Dumarán and off Bold Point the inshore hydrography was completed from Table Head to Trading Bay. The ship and one launch worked on the offshore hydrography, completing all the work outside of a line 1 mile east of Malanao and Sombrero Islands, down to latitude 9° 20' N. A large part of this work was hand-lead work.

The topography was completed from Table Head to Malanao Island. The work in Puerto Princesa was held up on account of unfavorable tides. All the head of the bay is a mangrove swamp and can be done only at low tides. Only some supplementary stations for the control of hydrography and topography were located. The ship was swung for compass deviations off Malanao Island.

The automatic tide gauge at Puerto Princesa was kept in continuous operation. A tide staff at Village Rocks was observed while hydrography was in progress in the vicinity. A tide staff was established at Aborlan and read while hydrography was in progress in the vicinity.

Puerto Princesa was used as headquarters. Sandakan, British North Borneo, was the coaling station.

During the month of June the following work was executed by this party:

Two triangulation stations in base expansion were established and occupied. Supplementary triangulation was extended to Panacan.

The hydrography was extended southward and two 65-foot hydrographic signals built. Two lines of deep soundings were run from latitude 9° 05' to Bancoran Island.

About 19.6 miles of topography was executed.

Two of the stations, Mount Beaufort and Stately Shoulder, were occupied, although the party had not returned from the latter on June 30. Mount Beaufort is about 3,800 feet high, while Stately Shoulder is about 3,000 feet high. It takes about 10 days to occupy one of these stations.

Five signals were built for extending the supplementary triangulation south from the line Arena-Native Point. It will be possible to extend this scheme to Blvouac Point, but it will not be possible to join up with a local scheme in Island Bay.

The ship and two launches were sounding when weather was favorable. The completed hydrography was extended to latitude $9^{\circ} 16' N.$, outside of the line between Sombrero and Arena Islands. The coral reef south of Imaguan extends to this latitude, requiring close development. As the hills in this vicinity are fronted by an extensive plain, it would be necessary to use a scale of 1:80,000 for the development of this bank, but by building some tall signals on Malanao, Sombrero, Arena, and Rasa Islands, it was possible to work on a scale of 1:40,000.

The peaks around Sultan Peak and Victoria Peak are so indefinite and so often in the clouds that it will be difficult to obtain good positions in the vicinity of Altnacraig and Marabout Shoals, except in the early morning.

The anchorage at Aborlan was developed, but the shoal water between Malanao Island and the mainland has not yet been surveyed.

The hydrography in Puerto Princesa was extended to a line west of Tidepole Point. This work was done while the base line was being measured.

On the run to and from Sandakan, lines of sounding were run between Bancoran Island and Palawan. The soundings were spaced closely in the latitude of Rosalia Reef, but no indication was found. Sextant positions were obtained in this vicinity, while dead reckoning was used for the rest of the run, with good bearings on Bancoran Island for determination of the southern ends of the lines.

The topography of Malanao Island and the shore line from Aborlan to Calver Point was completed. As the hills back of Aborlan do not come on a 1:20,000 topographic sheet, a sheet was laid out on a scale of 1:40,000 on which the contours only will be shown.

While the ship went to Sandakan for coal, a party was left at Puerto Princesa to continue the topography of the bay. Low tides occurred during the daytime during this week, and the worst part of the work was completed. Even at low tide the party had to wade continuously in mud and water up to the waist.

A typhoon passing to the northward during the week June 24 to 30, caused very rough weather. It was rough two days before the barometer fell.

[J. W. MAUPIN, Commanding Steamer *Fathomer*.]

SUMMARY OF RESULTS.—Triangulation: 18.4 miles of area covered, 3 signal poles erected, 3 stations in supplemental schemes occupied for horizontal measures, 2 geographic positions determined. Leveling: 2 permanent bench marks established. Topography: 7 square miles of area surveyed, 20.2 miles of general coast line surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 458.1 square miles of area covered, 1,602.2 miles run while sounding, 5,211 positions determined (double angles), 15,393 soundings made, 1 tide station established, 2 hydrographic sheets finished, scales 1:20,000 and 1:60,000.

From July 1 to 14 the steamer *Fathomer* was repairing and outfitting at Manila. After coaling at Cavite on July 14, the vessel sailed the same day for the working grounds, arriving at Burdeus Bay, Polillo Island, on July 20.

The work of the season included topography and hydrography on the east coast of Luzon in the vicinity of Polillo Island, and was done in cooperation with the party on the steamer *Pathfinder*.

On July 23 a camp was established on one of the Ula Islands for the launch hydrographic, topographic, and signal-building parties. The vessel then proceeded to Dahikan Bay, where a tide gauge and camp were established. This was used as the ships' headquarters throughout the season.

Considerable progress was made in the work during August, but in the latter part of the season the weather was unfavorable. Most of the work was in localities exposed to the open Pacific, where heavy swells made surveying operations on the outlying shoals hazardous and difficult.

In consequence of unfavorable weather conditions, work closed for the season on October 15. The *Fathomer* sailed direct for Manila on that date, arriving on October 18. From this date until the close of the month the vessel was at Engineer Island undergoing repairs and outfitting for the continuation of the work off Busuanga Island.

[S. D. WINSHIP, Commanding Steamer *Fathomer*.]

SUMMARY OF RESULTS.—Triangulation: 418.8 square miles of area covered, 27 signal poles erected, 1 observing tripod and scaffold built (20 feet in height), 9 stations in main scheme occupied for horizontal measures, 6 stations in supplemental schemes occupied for horizontal measures, 10 geographic positions determined. Leveling: 3 permanent bench marks established. Magnetic work: Ship swung at one sea station. Topography: 4.3 square miles of area surveyed, 18.4 miles of general coast line surveyed, 1 topographic

sheet finished, scale 1:20,000. Hydrography: 2,482.6 square miles of area covered, 4,109.1 miles run while sounding, 5,240 positions determined (double angles), 21,864 soundings made, 1 tide station established, 5 hydrographic sheets finished, scale of hydrographic sheets 1:80,000, 1:20,000, 1:40,000, and 1:100,000.

The command of the *Fathomer* was transferred on November 26, while she was undergoing repairs, which were completed December 26. Supplies and coal had been taken on in the meanwhile, and on the same day the vessel sailed for the working ground on the west coast of Busuanga Island, Calamian Group, arriving December 27.

Bench marks were established and connected with the tide gauge by leveling, a camp was established on shore, buoys and ranges for entering the harbor were repaired, and a general study was made of the work to be done. On December 29 hydrographic work was begun by the ship, heavy seas preventing any launch work.

The work of the party consisted of the completion of five hydrographic sheets in the vicinity of the northwest coast of Busuanga Island, which had been begun under the party in charge of John W. Maupin the year previous.

The greater part of this work was confined to development of shoals reconnoitered by the previous party and to work outside the 100-fathom curve.

The first of the year found the party on the working grounds with everything ready to prosecute the work diligently, all preliminaries, such as setting tide staff and establishing tide observer's camp, having been attended to in the last few days of the preceding year.

The center of the operations for the first six weeks was Illultuk Bay, on the west coast of Busuanga Island, but the ship rarely put in there except over Sunday, it being more convenient to anchor behind islands or on shoals nearer the work.

The weather at first was very discouraging. One northeast blow following hard on another made it necessary to work in the deep water fully exposed to the heavy seas, which swept the decks continuously. On two days it was necessary to seek shelter.

When these gales, which lasted about 10 days, had subsided, the northeast monsoon appeared to have blown itself out, for the following weeks brought excellent weather for hydrography, with very fair seeing conditions.

On February 18 the base of operations was transferred to Pangauaran River, Port Caltom, on the north coast of Busuanga, and from there the work around Hunter and Merope Rocks was carried on under generally excellent conditions.

Coal was obtained once from Manila and once from the coal pile at Uson Island. On January 5 a trip was taken to San Jose, Mindoro, to send a telegram to Manila.

During the period from March 2 to June 30, 1918, the *Fathomer* was employed in the unsurveyed portion of Cuyo West Pass and the Sulu Sea south to latitude 10° 21.5' N. The greater part of this was ship hydrography, the only triangulation involved being the tying in of a few small islands, the topography of which was to be done.

The week following March 2 was spent making minor repairs and getting the supplies necessary for a season's work. On March 10 the ship left for the working grounds in Cuyo West Pass, stopping two days, en route, at Coron for coal, and arriving at Cuyo on the 15th.

A single quadrilateral of secondary triangulation was extended off the base Patunga-Capnoyan, which was tied in to station Tabac Rock to strengthen the general scheme. Another quadrilateral of tertiary triangulation was extended to the south and east to tie in the three small islands there, and a filled triangle was formed on the base Capnoyan-Imalaguan to locate Piedra Blanca. All of this was completed.

To the westward a quadrilateral was extended from the base Norte-Dalanganem to determine the base Dalanganem-Carandaga, from which a small scheme can be extended to control the local topography. This work was in progress at the close of the year.

Observing was greatly hindered by the haze until the end of the northeast monsoon in the early part of May. Aside from this there were no difficulties to overcome.

One sheet of topography, on 1:20,000 scale, was completed, covering the small islands southwest of Cuyo Island with Paya Rock, Tabac Rock, and Piedra Blanca shown in subplans.

Another 1:20,000 sheet covering the Dalanganem Islands was partially done.

A tide staff was erected at Bisucay Island in approximately the same location as the former gauges and tied in to the bench marks there. The small amount

of inshore hydrography about Capnoyan Island and the islands southward was done by a launch party camped on Capnoyan Island. While waiting a favorable day for observing triangulation in the Dalanganem group a small amount of launch work was done there. The shoal westward of Piedra Blanca was developed by the launch, and the work plotted on the ship sheet, and on a favorable day the shoal in the vicinity of Elax Rock and Queen of the Sea Bank, which was reconnoitered by the ship, was developed by a launch party, using as a center signal a small boat anchored with wire in 50 fathoms.

All the remainder of the hydrography was done by the ship. The general plan of work has been to clean up from the eastward, doing the off-shore work whenever weather was favorable, saving the work nearer shore for weather when the seeing was poor, or the sea so rough as to make it necessary to seek shelter at night.

The work in the vicinity of the Dalanganem Islands was incidental to the triangulation there and to the development of the shoals reported as Queen of the Sea Bank and Elax Rock, which were the objects of a special effort requiring good seeing and smooth sea.

While working east and southeast of Piedra Blanca, the weather being favorable, the ship was allowed to drift during the night to determine the set of the current. In addition to this data, careful record of the set on trips to and from Iloilo was kept and plotted on the boat sheet. A very uniform set of 1 knot in a direction slightly south of east seems to prevail.

The only magnetic work was one ship swing on the sun azimuth.

Stopping off for a day en route to Iloilo, a reconnoissance was made of the Cagayan Islands. Particular effort was made to find an entrance to the inclosed area between the islands to be used as a ship anchorage, but without any results.

There was not sufficient time to make a comprehensive reconnoissance for triangulation, but enough was done to determine a favorable location for the base and the general trend of the progress of the scheme.

In addition to the prescribed work, an investigation was made and report transmitted on the shoals in the mouth of the Iloilo River. At the request of the presidente of Cuyo, the engineer of the bureau of lands, and the observer of the Weather Bureau, three bench marks were established at Cuyo and connected by four days' simultaneous readings with Bisucay.

[R. R. LUKENS, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Reconnoissance: 300 square miles of area covered, 9 lines of intervisibility determined, 5 points selected for scheme, length of scheme 30 miles. Triangulation (secondary): 1 signal pole erected, 3 observing tripods built (height 75, 68, and 25 feet), 6 stations in main scheme occupied for horizontal measures, 1 station in secondary scheme occupied for horizontal measures, 6 stations occupied for vertical measures, 16 geographic positions determined. Leveling: 0.5 mile of levels run, 3 permanent bench marks erected. Topography: 38 square miles of area surveyed, 38 miles of general coast line surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 125 square miles of area covered, 1,060.4 miles run while sounding, 4,072 positions determined (double angles), 18,378 soundings made, 1 tidal station established, 1 hydrographic sheet finished, scale of hydrographic sheets, two 1:20,000 one 1:60,000.

The work of this party was the continuation of general surveys along the southeastern coast of Palawan Island with the special object of extending the secondary triangulation to a junction with the work of the steamer *Mariadue*, which was being brought down from the northward.

From July 7 to 31 the vessel was at Manila undergoing repairs. On August 1 she sailed for the Palawan coast.

Upon arrival at the working grounds a camp was put out on Pirate Island, and the officer in charge was given instructions to carry on the topography and hydrography as he saw fit, but to make a finished survey as he went along. The ship then took up triangulation, building high signals along the beach and shifting parties around for trips into the interior stations. This caused a great deal of running with the ship, as the triangulation was 30 to 40 miles ahead of the hydrography, and therefore but little ship hydrography could be accomplished. Even when a day was available for sounding, the squalls and low-hanging clouds would usually stop work in the early afternoon.

The *Romblon* made trips to Sandakan for coal and water about every 24 days, leaving one or two parties in camp to carry on work in her absence.

From about September 20 the efforts of the whole party were concentrated on the triangulation, and a plan was laid out which, if successful, would insure the completion of the work by the time the ship went to Manila in October. The

success of this plan hinged on the ability to establish and occupy a station on Mount Gantung, one of the most difficult of all the Palawan peaks. The officer assigned to this task started out on September 25.

The ship proceeded to Sandakan for coal on October 3, and upon returning the officer sent to occupy Mount Gantung was picked up on October 8. His trip had been unsuccessful. The weather was bad and on the eighth day out his Tagbanua cargadores deliberately deserted him, and he was left no alternative except to return as best he could with his two sailors.

This unfortunate incident broke up all hope of finishing the work, and, owing to the continued bad weather, it was decided to return to Manila at once for supplies and cleaning boilers and to get back as soon as possible, in the hopes of encountering better weather during the change of monsoon. Accordingly the ship arrived in Manila on October 14 and plans were made to sail again on October 22.

On October 19, however, the matter of the transfer of the commanding officer of the *Romblon* to the Naval Reserve came to the attention of the commander in chief of the Asiatic Fleet, and he issued verbal orders that the vessel remain in port while he communicated with the Navy Department in Washington in regard to this assignment. Answer to this cable was not received until November 15, and as it was favorable, this officer was ordered into the Naval Service. In the meantime the ship had been held in Manila.

In accordance with instructions received from the Director of Coast Surveys, the command of the *Romblon* was turned over to another officer on November 17.

The launch was kept busy at inshore hydrography during all the time that the ship was on the working grounds. This work was carried from Iglesia Point to a point about 2 miles northeast of San Antonio Bay. The area covered is very full of shoals and reefs, and much development work was necessary. The offshore work was taken up by the ship when opportunity offered, but the prevalence of low-hanging clouds made it very difficult; indeed, 8 or 9 miles offshore seemed to be about the limit at the northern end of the work. The area of shoals seems to extend many miles offshore, and close work will be required to find all the dangers.

In development work a bright day was utilized, and the ship anchored on the shoalest part of the bank in question; then a small boat was put out to search the area thoroughly for coral heads and pinnacles. Enough lines were run to delineate the depth curves, but the great effort was to find the least depths.

Tanner-Bliss pressure tubes were used in the ship work, and they gave very good results. The ship's work joins that of the launch for a distance of about 15 miles and the soundings cross very well. Numerous up-and-down soundings were taken during the work to verify the tubes. Hand lead was used on all shoals and banks.

The topography was completed from Iglesia Point to Tami Point, the most of the work being done by a party in camp. Care was taken to establish many triangulation stations along the shore, so that the work is well controlled. Around Iglesia Point and part of San Antonio Bay the shore line is mangrove and mud, making the work very tedious. This section was done during low-water periods. The northern part of the work consists, in the main, of a fine sand beach.

The main mountain range does not come on the topographic sheets; therefore a 1:100,000 projection was made for the purpose of cutting in the mountain topography. Cuts were taken for this sheet when an opportunity offered itself, but it was not completed.

The triangulation was the most important part of the season's work, the object being to effect a junction with the work of the steamer *Marinduque* as brought down from the north. The reconnaissance was finished and all signals except one were up when the ship returned to Manila. The conditions governing this work were hard. One line of stations was on the central range, from 3,000 to 7,000 feet high, while the other line was on a wooded beach where high scaffolds were necessary. Continued bad weather and the prevalence of malaria were the features that prevented the completion of the work during this season.

In this work the officers have displayed some very fine qualities of courage and tenacity. To spend day after day in those mountains, cutting every foot of the trail, not knowing when all the cargadores may leave, chilled by the daily cold rain and unable to sleep much nights because of the cold, is a task that requires some nerve and determination. Added to this, one is being constantly preyed upon by leeches and the hands and feet get badly cut up by the thorns and briars.

The following is quoted from the report of the chief of party:

"The writer made one five-day trip to one of the easy stations, and he appreciates thoroughly what the other officers have gone through. When Mr. Egner's men left him at the 4,700-foot level en route to Gantung, it took himself and his two men six days to double-pack the equipment back to the nearest barrio. Both Mr. Egner and Mr. Shaw have contracted the malaria from these trips, but it is hoped that they will soon recover from the effects of it."

It was absolutely essential that the station be located on Gantung, for it is the only peak that shows from the station on Mantalingajan.

Day and night readings were made on the tide staff at Sir J. Brooke Point while the ship was on the working grounds. A subsidiary staff on Pirate Island was used while hydrography was in progress in the vicinity. Both staffs are referred to standard bench marks. No protected place suitable for an automatic gauge could be found. In southwest storms a very heavy sea rolls into the landing at Brooke Point, and it was necessary to rebuild the plain staff after nearly every storm.

No systematic current survey was made, but it was noted that there is a set to the northeast along the Palawan coast. This current no doubt is caused by prevailing winds, for in the height of the northeast monsoon, a current setting to the southwest was also encountered. In the run from Bugsuk Island to Cagayan Sulu Islands, a moderate set to the north was always found. In making this run the ship steered N. 49° W. and S. 40° E. with good results.

[LEONARD H. ZEMAN, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Triangulation: 296 square miles of area covered, 1 signal pole erected, 7 stations in main scheme occupied for horizontal measures, 6 stations occupied for vertical measures, 7 geographic positions determined, 11 elevations determined trigonometrically. Topography: 7 square miles of area surveyed, 16.4 miles of general coast line surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 81.6 square miles of area covered, 695.4 miles run while sounding, 2,260 positions determined (double angles), 8,792 soundings made, 1 tide station established, 1 hydrographic sheet finished, scale of hydrographic sheets, 1:20,000 and 1:60,000.

On November 17, 1917, the command of the steamer *Romblon* was transferred from R. R. Lukens to Leonard H. Zeman.

On November 20 the *Romblon* proceeded to the working grounds on the southeast coast of Palawan, arriving there on November 23. On November 24 the field work commenced. The field work consisted in a continuation of the ship hydrography, launch hydrography, topography, and main-scheme triangulation as brought up the southeast coast of Palawan by R. R. Lukens and party.

Coal was purchased at Sandakan, British North Borneo, a distance of about 200 miles from the working grounds. During runs for coal, parties were left in camps ashore to be engaged in triangulation, hydrography, and topography.

The inshore hydrography completed by the launch extended offshore a distance of about 3½ miles from a point 2 miles northeast of San Antonio Bay to Sir J. Brooke Point. The area surveyed disclosed many shoals which were subsequently developed. When the ship was not engaged on triangulation work, it took up the offshore hydrography from the point where the launch left off and extended the lines to the limit of visibility of shore signals. Tanner-Blish pressure tubes were used for the ship work, and they gave very satisfactory results.

The topography was completed from Tamil Point to Filantropa Point. Transverses were run between the main-scheme triangulation points on the beach.

The gap of 25 miles between the main-scheme triangulation, as brought down the island of Palawan from the northward and that brought up from the assumed datum at Balabac, was completed. Field computations yielded the following results at the junction: Length of line checks about 1:50,000; discrepancy in azimuth about 50 seconds; discrepancy in latitude about 20 seconds, and discrepancy in longitude about 27 seconds.

A tide staff was read every day at Sir J. Brooke Point between the hours of 6 a. m. and 6 p. m. No observations for currents were made.

The weather during the period covered by this report was excellent for all the branches of the field work.

On January 16, 1918, the ship sailed for Manila under orders received from the Director of Coast Surveys. A short stop was made at Puerto Princessa in order to obtain mail. On January 19, 1918, the ship tied up alongside the dolphins at Engineer Island, and on January 21 repairs to the vessel were commenced.

On March 13, 1918, the command of the steamer *Romblon* was transferred from L. H. Zeman to H. B. Campbell. The ship was still undergoing repairs on that date.

Owing to the fact that the lignum-vitæ of the stern bearing of the starboard propellor shaft had entirely worn away or dropped out, it was deemed necessary to use only the port engine of the ship in order to avoid possibility of bending the shaft or breaking the bearings. This faulty condition of the stern bearing was first noticed on the trip from Sandakan to the working grounds on January 2-3, 1918.

Several attempts were made to do ship hydrography, using only one engine, but owing to the prevalence of strong northeast monsoon weather this branch of the work was stopped.

The launch was engaged whenever the weather permitted in shoal development just southward of Brooke Point.

Additional work was done on the topographic sheet extending from Brooke Point to Nariz Point. The sheet was left unfinished, however, on account of orders to proceed to Manila. During the month of February while the ship was undergoing repairs at Engineer Island a line of levels was run from the automatic tide gauge at Pier 5 to the Intendencia Building. The tide staff at Pier 5 was also replaced.

[H. B. CAMPBELL, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Triangulation: 7 signal poles erected. Leveling: 0.2 mile of levels run. Magnetic work: Ship swung at one sea station. Topography: 0.1 square mile of area surveyed, 10 miles of general coast line run, 2 topographic sheets finished, scale 1:20,000. Hydrography: 581.9 miles of area covered, 252,512 miles run while sounding, 6,704 positions determined (double angles), 24,707 soundings made, 1 tide station established, 1 hydrographic sheet finished, scales of hydrographic sheets 1:20,000 and 1:60,000.

On March 13, 1918, the command of the steamer *Romblon* was transferred from Leonard H. Zeman to H. B. Campbell, at which time the *Romblon* was undergoing extensive repairs at Engineer Island, Manila.

The repairs were completed on April 16, and on April 19 the *Romblon* sailed for the working grounds. On April 23 the vessel arrived at Brooke Point, Palawan, and rebuilt the tide staff. On the next day the launch party was put in camp to do hydrography, and the ship started sounding.

Up to June 30 three trips were made to Sandakan, British North Borneo, for coal, a distance of nearly 200 miles. On these trips at least one camp party was left behind to continue field work.

Both the ship and the launch were continuously engaged in sounding. Anticipating, from general reports, that the weather would be the most favorable at this season, every effort was made to do as much sounding offshore with the ship as was practicable. The extent of this work, which is nearly all inside the 100-fathom curve, is shown on the progress sketch.

The launch worked from camp, and besides filling in the gap west of Ursula Island continued the inshore hydrography to Nariz Point, and developed a number of dangerous shoals which had been located by the ship.

Only sufficient topography was done to keep ahead of the launch party, as it was considered best to keep the two kinds of work together. The topography was completed to Nariz Point.

The main scheme in this locality having been completed, no observing was done. Seven intersection stations were built north of Nariz Point for control, three of them, between stations Nariz and Crawford, being built in tree tops. The remainder are in Island Bay. The approximate location of these stations is shown on the progress sketch. No observing was done.

The staff at Brooke Point was read from 6 a. m. to 6 p. m. during this period. No opportunity offered for observing currents without interference with other work, so none were observed.

[A. M. SOBIERALSKI, Commanding Steamer *Marinduque*.]

SUMMARY OF RESULTS.—Reconnaissance: 3 lines of intervisibility determined, 1 point selected for scheme. Triangulation: 1,270 square miles of area covered, 25 signal poles erected, 11 stations in main scheme occupied for horizontal measures, 22 stations in supplemental schemes occupied for horizontal measures, 16 stations occupied for vertical measures, 43 geographic positions determined, 43 elevations determined trigonometrically. Magnetic work: 2 stations occupied for magnetic declination, 1 sea station occupied for magnetic declination. Topography: 57 square miles of area surveyed, 46.4 square miles of general coast line surveyed, 8 miles of shore line of rivers surveyed,

1 mile of creeks surveyed, 2.6 miles of roads surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 528.4 square miles of area surveyed, 2,407.9 miles run while sounding, 7,920 positions determined (double angles), 33,675 soundings made, 5 tide stations established, 3 hydrographic sheets finished, scales one 1:40,000 and two 1:20,000.

On July 1 the *Marinduque* was at Manila undergoing repairs and outfitting. Upon the completion of these repairs the ship left Manila to resume work on the east coast of Palawan, arriving on the working grounds July 15. The next day a party was started to build and occupy triangulation station Anepahan, a 4,800-foot peak 17 miles inland, while the rest of the party took up hydrography in Honda Bay.

The only men available for the triangulation party were colonists from the Iwahig penal colony and civilized Tagbanuas, poor material, as experience had shown that the uncivilized Tagbanuas living in almost inaccessible villages in the mountains were the best for this kind of work. The difficulties in the way of reaching this station—its great distance in the interior of the island and its height—with such a poor party seemed almost insuperable, and for this reason no work was done on the triangulation pending the results of this expedition.

On July 29 after the party had been gone two weeks, some stragglers reached the ship who reported that the party had lost their way and had run out of provisions. A relief expedition was immediately started. The ship in the meantime had to run to Sandakan for coal. It was not until August 8, after an absence of 24 days, that the party was picked up; the station was occupied and all observations completed. Great credit is due to the officer in charge especially for his persistence after encountering difficulties that might well have discouraged him.

This was a typical experience during the prosecution of this triangulation, for there were stations such as Victoria, Cleopatra, and Stripe Peak that were even more difficult to reach. One can better appreciate the difficulties of those expeditions after reading Mr. Worcester's account, in his book, *The Philippine Islands*, pp. 115-124, of the difficulties encountered in the ascent of Thumb Peak, one of the "easy" stations in the scheme.

As soon as the party had returned from Anepahan the ship went to Separation Point, and during the rest of the month of August, Sundays and week days, three observing parties were kept continuously at work on the stations at the southern end of the scheme, while a fourth party was engaged clearing at triangulation station Crawford, where some enormous hard wood (Ipil) trees had to be cut down. The stations occupied were Sombrero, Arena, Calatugas, Pulute, Crawford, Albion, and Alboaba in the main scheme, and the supplemental stations Tagalinog, Arrecife, Emelina, and Cay.

Most of these stations were either difficult of access or required heavy clearing, or both. Albion Head, on the west coast, was reached by using an almost obliterated trail across the narrow part of the island at Separation Point to Alphonso XIII, where a native boat had to be secured, and then a precipitous cliff 600 feet high had to be climbed. The natives were afraid to make the ascent, as the place is reputed to be infested with snakes, and the rocks are so sharp that their feet are always badly lacerated in making the ascent.

Pulute, a 3,000-foot peak, 11 miles inland, was also reached from Separation Point, the trail passing through a fairly well-settled country. A considerable amount of clearing was done at this station.

Both Aboaba and Crawford required a large amount of heavy cutting.

Calatugas was a steep, hard climb, 2,500 feet, and required much clearing. The other stations were easy to reach.

This work was finished on August 31, and after coaling at Sandakan the ship returned to Puerto Princesa where it was necessary to blow down in order to make some minor repairs to the boiler. The time was utilized in securing men and making preparations for two triangulation parties to occupy triangulation stations Central and Thumb Peak. While these parties were in the field the rest of the party, taking advantage of a spell of fine weather, completed a large area of hydrography from Bold Point to Pasco Point, including the development of a large number of shoals. On September 22 the triangulation parties returned and the ship left for Manila for repairs and supplies.

During this stay at Manila the ship was hauled out, the bottom cleaned, and a new rudder stock installed.

On October 17 the ship returned to the working grounds, and during the rest of the month was engaged on hydrography and topography in Honda Bay. One party completed the observations at triangulation stations Table Head and Sombrero.

During the first half of November the weather was very bad, with an unprecedented large rainfall, and work could be carried on only intermittently. However, as in this country a spell of bad weather is almost always followed by a spell of correspondingly fine weather, all preparations were made for prosecuting the work vigorously—ship was coaled, extra hands secured, and parties advantageously distributed—so that when the weather cleared up (about November 19) everything was ready for work. A topographic and three hydrographic parties were kept almost continuously at work until December 19, when the work was closed and the ship returned to Manila.

During this month of fine weather (from November 19 to December 19) over a thousand miles of hydrography (most of it close development or deep-sea sounding, where it is difficult to run up large mileage) and over 50 miles of topography were completed, besides building and occupying 9 triangulation stations in the supplementary scheme.

The rest of the month was spent at Manila repairing and laying up the ship.

The results of the season's work are as follows:

The observations in the main-scheme triangulation were completed as far south as the line Pulute-Crawford, where it joins the work being done by the party on the steamer *Romblon*, thus completing the main scheme down to the Mantangule base. One angle at Albion Head was not observed, the observer mistaking another peak for Anepahan. The station is not very difficult to reach, but exceptionally clear weather is required to observe this long line (67 kilometers).

Besides the supplementary stations already established at Malanao, Inaguan, Emelina, and Cay, stations were placed on Arrecife and Tagalinog Islands. Some fishermen stripped the latter signal of cloth (a valuable article among the natives) and made it impossible to observe this station from Calatugas and Pulute.

All the observing was completed on the supplementary scheme in Puerto Princesa, and a supplementary scheme was carried between Malanao Island and the mainland. This latter scheme can be carried one or two figures farther northward.

Control for topography southward of Sombrero Island can easily be obtained by establishing supplementary stations, observing from main-scheme stations which are easy to reach.

The topography of the shore line from Addison Point to Table Head was completed and contours were shown as far inland as possible. All the work was done on a scale of 1:20,000.

The hydrography has been carried down to Table Head, including Binunsallan Bay, the entrance to Puerto Princesa, and all of Honda Bay, and extending out to about 800 fathoms; in some places out to the 1,000-fathom curve. All of Honda Bay, including the complicated area in the northwest part of the bay, was thoroughly developed. All the inshore area was covered with lines not more than 165 meters apart, even in depths of 25 fathoms.

The shoal marked on the chart "10 P. D." in latitude $9^{\circ} 43'$, longitude $119^{\circ} 03'$, was found in approximately the position shown and developed. An immense area in Honda Bay of coral formation extending 10 miles offshore was thoroughly developed.

A line of deep-sea soundings was carried from latitude $9^{\circ} 13'$ N. northward while en route from Sandakan to Puerto Princesa.

Some reconnaissance lines were run by the ship when running between triangulation stations.

Many uncharted shoals were discovered. The office was kept informed so that notices of these shoals could be published.

The same stupendous slopes near the 100-fathom curve as were found around Pasig Shoal were also found along this stretch; a slope of 70 per cent (70 feet in 100 feet) was often encountered.

An automatic tide gauge was kept continuously in operation at Puerto Princesa. Tide staffs were observed at Tinitian, Babuyan, Makesi Island, and Village Rocks during the progress of hydrography in their respective vicinities.

The same remarkable tides mentioned in previous reports were recorded at Puerto Princesa.

No opportunity occurred to take systematic current observations. While occupying triangulation station Tagalinog, located on an island 13 miles offshore, with very deep water around it, the ship anchored in 16 fathoms very

close to shore a single observation of 2½ knots was made, but the anchor would not hold, and the ship was swept away. Strong currents were noticed between this island and the mainland.

Two stations were occupied for magnetic declination.

The ship was swung for compass deviations (16 headings) in latitude 9° 45' N., longitude 118° 50' E., using a range of two triangulation stations instead of sun azimuths. The bearing was taken both with the compass and the pelorus.

On account of the high cost of coal in the Philippines, it was necessary to run to Sandakan, British North Borneo, 240 miles distant, for coal. However, it is possible to coal so much faster at Sandakan than at Puerto Princesa that there was not a great loss of time. A deck load of coal was always taken.

[EOLINE R. HAND, Commanding Steamer *Research*.]

SUMMARY OF RESULTS.—Topography: 10 square miles of area surveyed, 25 miles of rivers surveyed, 2 miles of roads surveyed, 1 topographic sheet finished, scale 1:20,000. Hydrography: 58.5 square miles of area covered, 556.7 miles run while sounding, 2,189 positions determined (double angles), 8,221 soundings made, 2 tide stations established, 8 hydrographic sheets finished, scales 1:5,000, 1:20,000, and 1:40,000.

The survey of Manila Bay, which was in progress at the beginning of the fiscal year, was completed on August 24.

The work done after June 30, comprised 55 square miles of ship hydrography in the center of the bay and topography and sounding up the Orani and Pasag Rivers to the town of Guagua.

The sounding in the center of the bay was continued on the 1:40,000 scale sheet, with lines spaced about 250 meters apart, a somewhat greater interval than that used on the 1:20,000 sheets contiguous to the shore. The depths ranged between 9 and 20 fathoms, and the bottom was invariably mud and remarkably even. The survey of the waterways to Guagua was desirable, since they are traversed regularly by the Manila steamers. As these rivers are bordered with swamps for the entire distance, the topography was difficult. It is all stadia traverse with ample control. The soundings were between 2 and 5 fathoms. To determine the difference of time of tide turnings between the upper end, the mouths, and Manila, for reduction data, stations were established both at Sexmoan and Orani for simultaneous readings, the standard being at Manila.

A list of landmarks was furnished to be plotted on the revised issue of the chart of Manila Bay in order that the navigator may be able to accurately determine his position with reference to the plotted soundings.

After the completion of the work of the steamer *Research* in Manila Bay and pending the return of the vessel to the Philippine Government, a small area of about one-half mile immediately behind the North Breakwater, Manila Bay, was closely sounded for the information of the division of port works, presumably as a basis for calculating the extent and cost of dredging operations. The launch was used in this work, and lines of soundings 20 meters apart were run about normal with the sea wall.

SPECIAL DUTY.

NEW YORK.

EXHIBIT OF THE COAST AND GEODETIC SURVEY AT THE SOUTHERN COMMERCIAL CONGRESS.

[ISAAC WINSTON.]

An exhibit illustrative of the work and methods of the United States Coast and Geodetic Survey was made at the meeting of the Southern Commercial Congress held in the Hotel Astor, New York City, from October 15 to 17, 1917.

The space occupied was 13 by 29 feet, and the instruments were arranged to show the progress from astronomic work through geodetic work, magnetic work, topographic work, and hydrographic work to the chart as the finished product in the development of commerce. Charts and statistics of the principal southern ports and of New York Harbor and approaches were shown.

Six bureaus of the Department of Commerce, namely, the Steamboat-Inspection Service, the Census, Bureau of Foreign and Domestic Commerce, Bureau of Fisheries, Bureau of Lighthouses, and Coast and Geodetic Survey, participated, and the Chief Clerk of the Department of Commerce was present as the representative of the department in charge of the exhibit.

The greater part of the hall was occupied by exhibits from several States showing their products and resources.

EXHIBIT OF THE UNITED STATES COAST AND GEODETIC SURVEY AT THE NATIONAL MOTOR BOAT SHOW.

[ISAAC WINSTON.]

An exhibit illustrative of the work and methods of the United States Coast and Geodetic Survey was made at the National Motor Boat Show held in the Grand Central Palace, New York City, January 19 to 26, 1918.

A space 12 by 30 feet was assigned to the Survey on the mezzanine floor in the front of the building near the elevators, and a frame with 10 large wings was procured for use in displaying charts and photographs. One hundred and eighty feet of wall space were also available for display purposes.

A collection of charts and publications was prepared at the Coast and Geodetic Survey office to supplement the publications on hand at the field station.

The articles for exhibit were delivered at the Grand Central Palace January 18, and were placed in position on the following day and evening. On January 21 an officer detailed from the Washington office arrived and served until the close of the exhibition.

The charts showing Long Island Sound and the approaches to New York were joined so as to form a continuous whole, and attracted much attention. About 200 different charts fastened together in series were displayed on tables, and they were examined with interest by many persons.

Charts showing the wrecks that have occurred on the coast of Alaska, the relative size of different countries superimposed on the United States, the steamer routes of the world with distances between ports, the magnetic declination in the United States, and the cloud formations as classified for observation purposes were placed on the wings of the chart exhibitor and on the wall space.

All available chart catalogues, light lists, buoy lists, tables of distances between ports, catalogues of publications on nautical subjects, coast pilots, tide tables, inside route pilots, pilot rules, International Rules of the Road, Notices to Mariners, Nautical Almanacs, etc., were displayed on tables for the information of the public. These included publications of the Bureau of Lighthouses, the Hydrographic Office of the Navy Department, and the Coast and Geodetic Survey. Orders were taken for charts, coast pilots, and tide tables.

The chart of New York Harbor, made by the British before the Revolutionary War was taken from the field station to the show and attracted much attention.

One copy of each of the publications referred to above was displayed as a sample of what was available for the use of mariners. The photographs were arranged in series on the wings of the chart exhibitor to illustrate the work of the Survey.

A considerable number of publications describing the work of the Survey and the elements of chart marking were distributed to visitors.

The instruments shown were a sextant, three-arm protractor, parallel rule, and boat compass.

A large national flag, a banner of the Secretary of Commerce, the Bureau service flag, and two Bureau banners were used as decorations and the sign Coast and Geodetic Survey was displayed.

The exhibit was classed as "educational" in catalogue.

No expense in connection with the exhibit was incurred on account of the Government, the incidental expenses being paid by the National Motor Boat Show.

INSPECTION OF CHART AGENCIES.

[H. R. GARLAND.]

In January an inspection was made of the agencies for the sale of Coast and Geodetic Survey charts and nautical publications at Baltimore (Md.), Wilmington (Del.), Philadelphia (Pa.), and New York City (N. Y.) for the purpose of examining their stocks of charts and publications.

At each agency the charts and publications were inventoried, the obsolete charts and publications condemned and destroyed, receipts therefore given, and copies sent to the office at Washington. The value of the charts and publications remaining on hand was computed, and the figures furnished to the agents as a basis for their reports. The methods of caring for the charts and publications and the general interest shown by the agencies in the sale of them were noted.

DELAWARE.

[J. J. GILBERT.]

In April, 1918, at the request of the William Cramp & Sons Ship & Engine Building Co., the location of the north range west beacon of the trial course at Lewes, Del., which had been undermined and blown down by a storm, was re-determined, and the position was marked by surface and underground marks in order that the beacon might be reerected in the proper position.

This work was done at the expense of the Cramp & Sons Co.

VIRGINIA.

TRIAL COURSE IN POTOMAC RIVER FOR THE GENERAL SHIPBUILDING & AERO CO.

[JEAN H. HAWLEY.]

In November, 1917, a trial course 1 nautical mile in length was laid off in the Potomac River at Alexandria at the request of the General Shipbuilding & Aero Co. The work of laying out the trial course was begun November 13 and was concluded November 16.

The spire on the belfry of the new Colored Catholic Church, at the corner of Wythe and Columbus Streets was selected as the rear range at the north end of the course, and the starting point for the traverse was located on the east curb of Fairfax Street, at a point where a line perpendicular to the curb line intersects this spire. A wooden beacon was constructed on the bluff just east of Fairfax Street for the front range on this line.

The traverse was run along the east curb of Fairfax Street for a distance of 1,853.25 meters. A 50-meter steel base tape under a tension of 10 kilograms was used in running this traverse.

At the end of this traverse a line to establish the south end of the course was laid off at right angles to the curb line and marked by two wooden range beacons.

The lines at right angles to the street were measured with a 4-inch theodolite set up over each end of the traverse, the curb line being used as the initial line in each case.

OHIO.

TRIAL COURSE FOR DIRIGIBLES.

[H. P. RITTER.]

In compliance with a request from the Navy Department, a determination was made in August, 1917, of the length of a trial course for dirigibles, located in Portage County eastward of the aviation grounds and about 12 miles south-east of Akron, Ohio.

The course had been laid out by the engineers of the Goodyear Tire & Rubber Co. to be used in connection with their aviation school and for the official trials of the United States naval dirigibles. The course was designed to be 2 nautical miles long, and each end and the middle are marked by a range consisting of two range poles set at right angles to the course. The poles are 50 feet apart and near the top have wires stretched between them for the purpose of observing from the ground the time of transit of the dirigibles across the range.

The direction of the course is north and south and parallels the road passing through the town of Suffield. The ranges are placed just west of the road. The surface of the ground along the course is undulating and ranges between about 1,150 and 1,250 feet above mean sea level.

The measurements for the length of the course were made along the edge of the road on a line parallel to the course and at right angles to the ranges. Hubs 50 meters apart were set along the line and a forward and backward measure made. A line of levels was run over the measured line, and corrections for the slopes of the ground determined. Field work was completed August 24.

CALIFORNIA, OREGON, AND WASHINGTON.

[J. J. GILBERT.]

In June an inspection trip was begun by an officer of the Survey along the Pacific coast of the United States for the purpose of determining the condition

of the surveys on that coast, in order to meet immediate needs for surveys and charts under present conditions.

At the same time an inspection was made of the chart agencies of the Bureau on that coast.

Respectfully,

R. L. FARIS,
Acting Superintendent.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
SUPERVISING INSPECTOR GENERAL, STEAMBOAT
INSPECTION SERVICE

767

REPORT

OF THE

SUPERVISING INSPECTOR GENERAL

STEAMBOAT-INSPECTION SERVICE.

DEPARTMENT OF COMMERCE,
STEAMBOAT-INSPECTION SERVICE,
Washington, August 31, 1918.

SIR: Herewith is submitted the report of the operations of the Steamboat-Inspection Service for the fiscal year ended June 30, 1918, as required by section 4403, Revised Statutes, and the Department regulations relating thereto.

ORGANIZATION.

The following positions were embraced in the Steamboat-Inspection Service at the close of business on June 30, 1918:

At Washington, D. C.:	
Supervising Inspector General.....	1
Chief clerk (who is Acting Supervising Inspector General in the absence of that officer).....	1
Clerks.....	9
Messenger.....	1
In the Service at large:	
Supervising inspectors.....	10
Traveling inspectors.....	2
Local inspectors of hulls.....	48
Local inspectors of boilers.....	48
Assistant inspectors of hulls.....	64
Assistant inspectors of boilers.....	64
Clerks to boards of local inspectors.....	73
	321

Nineteen permanent positions were added to the Service during the year, as follows:

One clerk in the office of the Supervising Inspector General, Washington, D. C.

Three assistant inspectors of hulls, and three assistant inspectors of boilers at the port of New York, N. Y.

A board of local inspectors was established at Tampa, Fla., consisting of a local inspector of hulls and a local inspector of boilers.

One assistant inspector of hulls and one assistant inspector of boilers at each of the following ports: Seattle, Wash.; Philadelphia, Pa.; and Boston, Mass.

One additional clerk in each of the following offices: San Francisco, Cal.; Seattle, Wash.; Cleveland, Ohio; and Tampa, Fla.

SUMMARY OF OFFICE WORK.

Following is a summary of the work of the Office of the Supervising Inspector General for the fiscal year ended June 30, 1918:

Copies of circular letters issued.....	159,174
Copies of Steamboat-Inspection Service bulletins issued.....	27,400
Excursion permits reported issued.....	107
Permits to use oil as fuel on steamers.....	173
Miscellaneous accounts examined and approved.....	2,010
Index (card system) correspondence, new numbers.....	1,600
Estimated number of letters answered.....	47,500
Personal expense accounts examined and approved.....	2,679
Daily reports of inspectors examined and approved.....	22,630
Returns of nonexpendable property received, examined, and filed.....	63
Returns of expendable property received, examined, and filed.....	63
Requisitions for supplies, printed stationery, and blank forms received, examined, and approved.....	2,100
Reports of casualties and violations of law recorded and filed.....	1,867
Special reports on casualties prepared and submitted to the Secretary of Commerce.....	1,008
Vessel-inspection cards received, examined, and filed.....	22,500
Reports of tests of materials at mills received, recorded, and filed.....	1,346
Reports examined of life preservers inspected at factory.....	622
License cards received, examined, and filed.....	34,000
Reports of absences received, examined, and filed.....	636
Reports of circular letters acknowledged, received, examined, and filed.....	744
Records of fusible plugs inserted in boilers received, examined, and filed.....	11,500
Invoices of supplies, blank forms, and printed stationery received, checked, and forwarded.....	6,200
Card records of certificates of service issued to able seamen received, examined, and filed.....	15,000
Card records of certificates of efficiency issued to lifeboat men received, examined, and filed.....	12,000

EXPENDITURES.

Following is a detailed account of the expenditures for the fiscal year ended June 30, 1918:

Salaries, Supervising Inspector General, supervising and local inspectors, assistant inspectors, traveling inspectors, and clerks to local boards....	\$521,251.87
Salaries, clerks, and messenger in the Office of the Supervising Inspector General at Washington, D. C.....	12,960.60
Total.....	534,202.37
Traveling expenses (actual).....	81,273.44
Rents, offices.....	20,337.49
Furniture, instruments, etc., and repairs to same.....	7,147.51
Stationery, supplies, and transportation of same.....	6,258.05
Telephone rents and telegrams.....	3,801.27
Witnesses' fees and mileage in cases of investigation.....	629.79
Ice, fuel, and electric light.....	444.06
Moving offices.....	269.00
Janitor service.....	201.27
Toilet service, laundry, soap, etc.....	184.63
Marine publications and official railway guides.....	70.92
Miscellaneous.....	60.20
Total traveling and miscellaneous expenses.....	120,677.63

Salaries as noted above.....	\$534, 202. 37
Total expenditures for year ended June 30, 1918.....	654, 880. 00
Total expenditures for year ended June 30, 1917.....	619, 759. 56
Increase, 1918.....	35, 120. 44
Salaries, 1918.....	534, 202. 37
Salaries, 1917.....	503, 691. 85
Increase, 1918.....	30, 510. 52
Contingent expenses, 1918.....	120, 677. 63
Contingent expenses, 1917.....	116, 067. 71
Increase, 1918.....	4, 609. 92
Rents, 1918.....	20, 337. 49
Rents, 1917.....	13, 330. 16
Increase, 1918.....	7, 007. 33
Traveling expenses, 1918.....	81, 273. 44
Traveling expenses, 1917.....	78, 419. 96
Increase, 1918.....	2, 853. 48

As shown above, there were increases in salaries, traveling expenses, and rents over the previous year. The increases in salaries and traveling expenses were due to the appointment of additional inspectors during the year. The increase in rents was due to the fact that during the year several of the field offices of the Bureau were moved from Government buildings to private buildings and that one new local board was established.

NUMBER, CLASS, AND TONNAGE OF VESSELS INSPECTED.

There is submitted herewith a tabulated statement showing the number, class, and tonnage of vessels regularly inspected by this Service and granted certificates.

CERTIFICATES OF INSPECTION ISSUED TO STEAM AND MOTOR VESSELS AND TO BARGES DURING THE FISCAL YEAR ENDED JUNE 30, 1918, BY DISTRICTS.

Supervising district.	Local district.	Domestic vessels.						Foreign passenger steam vessels.		Total.			
		Steam vessels.		Motor vessels.		Passenger barges.		Seagoing barges.			Total.		
		Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.		Num-ber.	Gross tonnage.	
First.....	San Francisco, Cal.....	334	645,580	89	24,268	7	11,513	7	11,513	430	681,410	457	830,169
	Honolulu, Hawaii.....	19	9,868	7	567	1	913	1	913	27	148,769	457	830,169
	Juneau, Alaska.....	34	2,161	9	820	2	2,809	2	2,809	43	2,981	43	2,981
	Los Angeles, Cal.....	19	29,441	9	735	3	3,896	3	3,896	30	32,985	30	32,985
	Portland, Ore.....	122	122,106	30	23,690	1	538	1	538	156	150,230	156	150,230
	St. Michael, Alaska.....	22	9,164	4	132	1	186	14	22,594	37	402,017	32	14,179
	Seattle, Wash.....	291	347,651	47	31,772	14	22,594	352	402,017	30	200,184	382	602,201
	New York, N. Y.....	1,211	1,033,445	58	24,963	4	2,175	127	114,157	1,400	1,174,640	1,503	2,192,083
	Albany, N. Y.....	158	51,073							158	51,073	158	51,073
	New Haven, Conn.....	65	7,673	36	1,178					101	8,851	101	8,851
Third.....	Philadelphia, Pa.....	287	362,438	40	3,405	75	68,808	75	68,808	402	434,661	403	446,556
	Norfolk, Va.....	217	194,365	46	1,074	2	620	81	64,020	346	280,079	346	280,079
	Baltimore, Md.....	222	220,888	42	1,942	38	28,666	302	251,496	302	251,496	302	251,496
	Charleston, S. C.....	66	7,757	8	211	3	887	76	8,855	83	8,855	76	8,855
	Jacksonville, Fla.....	32	14,863	28	2,038	9	9,669	99	26,600	69	26,600	69	26,600
	Savannah, Ga.....	60	34,166	6	3,570			3	1,611	69	39,337	69	39,337
	St. Louis, Mo.....	91	19,402	15	429	1	263			106	19,831	106	19,831
	Dubuque, Iowa.....	38	8,846	34	1,211	1	263			71	6,320	71	6,320
	Bangor, Me.....	175	176,626	3	97	61	56,851			239	233,574	240	242,185
	New London, Conn.....	39	7,661	16	2,086	6	6,973	6	6,973	61	363	61	17,073
Sixth.....	Portland, Me.....	41	12,063	9	510	4	5,655	4	5,655	54	18,228	54	18,228
	Providence, R. I.....	45	42,276	1	41	15	13,547	6	50,940	61	56,963	66	106,703
	Louisville, Ky.....	71	71,300	11	346	22	21,193	104	92,839	104	92,839	104	92,839
	Evansville, Ind.....	28	4,612	8	446	36	5,068	36	5,068	36	5,068	36	5,068
	Memphis, Tenn.....	35	6,042	7	166	41	6,172	41	6,172	41	6,172	41	6,172
	Nashville, Tenn.....	69	6,042	7	166	66	6,198	66	6,198	66	6,198	66	6,198
	Pittsburgh, Pa.....	61	7,559	1	29	53	7,965	53	7,965	53	7,965	53	7,965
	Cincinnati, Ohio.....	76	10,194	2	66	78	10,260	78	10,260	78	10,260	78	10,260
	Point Pleasant, W. Va.....	34	8,607			34	8,607			34	8,607	34	8,607
	Detroit, Mich.....	40	4,865	2	99	42	4,904			42	4,904	42	4,904
Seventh.....	Chicago, Ill.....	122	204,384	7	194	129	204,578	4	5,431	133	210,009	133	210,009
	Duluth, Minn.....	116	294,668	9	482	125	295,150			125	295,150	125	295,150
	Grand Haven, Mich.....	112	346,366	3	88	113	346,453			113	346,453	113	346,453
	Marquette, Mich.....	61	32,563	6	217	57	32,780			57	32,780	57	32,780
	Milwaukee, Wis.....	28	13,491	1	28	29	13,519			29	13,519	29	13,519
Eighth.....		122	210,473	10	4,473					132	214,946	133	214,946

Ninth.....	Port Huron, Mich.....	57	43,945	.....	.....	.....	.....	.....	.....	57	43,945	5	16,511	62	40,455
	Cleveland, Ohio.....	228	780,211	.....	.....	.....	.....	.....	.....	228	780,211	.....	.....	228	780,211
	Buffalo, N. Y.....	213	407,729	.....	.....	.....	.....	.....	.....	213	407,729	.....	.....	213	407,729
	Burlington, Vt.....	13	2,667	.....	.....	.....	.....	.....	.....	13	2,667	.....	.....	13	2,667
	Oswego, N. Y.....	35	15,510	.....	.....	.....	.....	.....	.....	35	15,510	.....	.....	35	15,510
	Toledo, Ohio.....	70	127,980	.....	.....	.....	.....	.....	.....	70	127,980	.....	.....	70	127,980
Tenth.....	New Orleans, La.....	219	122,128	.....	.....	.....	.....	.....	.....	219	122,128	.....	.....	219	122,128
	Albany, N. Y.....	63	61,887	.....	.....	.....	.....	.....	.....	63	61,887	.....	.....	63	61,887
	Washington, Pa.....	73	19,811	.....	.....	.....	.....	.....	.....	73	19,811	.....	.....	73	19,811
	Mobile, Ala.....	10	5,218	.....	.....	.....	.....	.....	.....	10	5,218	.....	.....	10	5,218
	San Francisco, Cal.....	11	6,094	.....	.....	.....	.....	.....	.....	11	6,094	.....	.....	11	6,094
	Tampa, Fla.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total, 1918.....	5,532	6,203,124	665	153,122	543	679,840	6,788	6,846,356	227	1,618,340	7,015	8,464,686	228	8,464,686
	Total, 1917.....	5,530	5,375,156	665	69,961	540	501,288	6,776	5,960,310	208	1,289,279	6,964	7,246,580	210	7,246,580
	Increase (+) or decrease (-)	+2	+828,068	+30	+83,161	-3	-635	-17	-21,448	+19	+329,061	+31	+1,218,107	+18	+1,218,107

VESSELS INSPECTED AND OFFICERS LICENSED DURING THE FISCAL YEAR ENDED JUNE 30, 1918, BY GEOGRAPHICAL DIVISIONS.

Geographical divisions.	Domestic vessels.										Foreign passenger steam vessels.				Total.				Officers licensed.			
	Steam vessels.		Motor vessels.		Passenger barges.		Seagoing barges.		Total.		Num-ber.		Gross tonnage.		Num-ber.		Gross tonnage.		Steam vessels.		Motor vessels.	
	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.	Num-ber.	Gross tonnage.
Pacific coast.....	841	1,165,971	185	81,964	2	724	27	41,774	1,065	1,250,463	69	415,535	1,134	1,765,988	3,968	2,032	3,968	2,032	.....	.....	.....	.....
Atlantic coast.....	2,678	2,226,603	303	41,361	6	2,765	444	391,037	3,431	2,671,796	111	1,099,112	3,542	3,760,908	12,214	4,109	12,214	4,109	.....	.....	.....	.....
Western rivers.....	1,450	66,976	75	2,699	2	660	.....	.....	1,527	73,335	.....	.....	1,527	73,335	.....	.....	1,527	73,335	.....	.....	.....	.....
Northern lakes.....	1,168	2,597,828	40	6,888	1	107	.....	.....	1,209	2,613,821	27	82,314	1,236	2,696,135	3,496	1,102	3,496	1,102	.....	.....	.....	.....
Gulf coast.....	385	222,748	82	21,490	7	5,984	72	47,029	566	297,251	20	61,379	576	358,630	1,890	1,122	1,890	1,122	.....	.....	.....	.....
Total, 1918.....	5,532	6,203,124	665	153,122	18	10,270	543	679,840	6,788	6,846,356	227	1,618,340	7,015	8,464,686	23,034	9,273	23,034	9,273	.....	.....	.....	.....
Total, 1917.....	5,530	5,375,156	665	69,961	21	10,905	540	501,288	6,776	5,960,310	208	1,289,279	6,964	7,246,580	16,431	11,324	16,431	11,324	.....	.....	.....	.....
Increase (+) or decrease (-)	+2	+828,068	+30	+83,161	-3	-635	-17	-21,448	+19	+329,061	+19	+329,061	+31	+1,218,107	+7,523	-2,051	+7,523	-2,051	.....	.....	.....	.....

MISCELLANEOUS INSPECTIONS.

Following is a statement of steam vessels granted letters of approval of designs of boilers, engines, and other operating machinery inspected under an act of Congress approved June 9, 1910, which vessels are not inspected annually, only one inspection being made for letter of approval; hulls of United States Government vessels inspected; and boilers in or for United States Government steamers and buildings inspected during the year ended June 30, 1918:

Local inspection district (port).	Steam vessels granted letters of approval.		Government vessels inspected.	Government boilers inspected.	Local inspection district (port).	Steam vessels granted letters of approval.		Government vessels inspected.	Government boilers inspected.
	Number.	Gross tonnage.				Number.	Gross tonnage.		
San Francisco, Cal.			4	64	Cincinnati, Ohio.			1	28
Honolulu, Hawaii				27	Point Pleasant, W. Va.	1	21		81
Juneau, Alaska			1	5	Detroit, Mich.				8
Los Angeles, Cal.				11	Chicago, Ill.	1	14		
Portland, Oreg.	2	119		52	Duluth, Minn.				12
St. Michael, Alaska				15	Grand Haven, Mich.	4	77	1	32
Seattle, Wash.	1	42	2	42	Marquette, Mich.			3	10
New York, N. Y.	2	91	26	134	Milwaukee, Wis.	1	30	7	18
Albany, N. Y.				6	Cleveland, Ohio.	2	25	1	2
New Haven, Conn.	1	35			Buffalo, N. Y.	2	70		
Philadelphia, Pa.				39	Oswego, N. Y.				10
Norfolk, Va.	2	37		30	Toledo, Ohio.	3	92		
Baltimore, Md.				75	New Orleans, La.			15	131
Charleston, S. C.	3	40		45	Apalachicola, Fla.				3
Jacksonville, Fla.	2	101		13	Galveston, Tex.				29
Savannah, Ga.				220	Mobile, Ala.	3	111		76
St. Louis, Mo.	1	4	5	100	San Juan, P. R.				1
Dubuque, Iowa.				18	Tampa, Fla.				8
Boston, Mass.				7					
New London, Conn.				24	Total, 1918.	33	978	84	1,716
Portland, Me.				24	Total, 1917.	51	1,328	82	1,580
Providence, R. I.			2	24					
Louisville, Ky.	1	45		60	Increase (+)				
Evansville, Ind.				4	or decrease				
Memphis, Tenn.	1	24	18	110	(-)	-18	-350	+2	+126
Nashville, Tenn.				84					
Pittsburgh, Pa.				62					

REINSPECTIONS.

Following is a statement of reinspections of passenger and ferry steamers made by boards of local inspectors during the year:

Local inspection district.	Passenger steamers.	Ferry steamers.	Total.	Local inspection district.	Passenger steamers.	Ferry steamers.	Total.
San Francisco, Cal.		91	91	Pittsburgh, Pa.	4	2	6
Los Angeles, Cal.		5	5	Cincinnati, Ohio.	9	13	22
Portland, Oreg.	19	14	33	Point Pleasant, W. Va.	3	9	12
Seattle, Wash.	3	4	7	Detroit, Mich.	45	29	74
New York, N. Y.	104	189	273	Chicago, Ill.	33		33
Albany, N. Y.	60	34	94	Duluth, Minn.	13	11	24
New Haven, Conn.	6		6	Grand Haven, Mich.	91	8	99
Philadelphia, Pa.	42	45	87	Marquette, Mich.	4		4
Norfolk, Va.	92	36	128	Milwaukee, Wis.	11		11
Baltimore, Md.	118		118	Port Huron, Mich.	7	2	9
Charleston, S. C.	9	1	10	Cleveland, Ohio.	14		14
Jacksonville, Fla.	6	3	9	Buffalo, N. Y.	38	8	46
Savannah, Ga.	20		20	Burlington, Vt.	6	6	12
St. Louis, Mo.	53	21	74	Oswego, N. Y.	12	2	14
Dubuque, Iowa.	22	7	29	Toledo, Ohio.	63	64	126
Boston, Mass.	1	7	8	New Orleans, La.	5		5
Bangor, Me.	8		8	Mobile, Ala.	26	6	32
New London, Conn.	34		40	San Juan, P. R.	4		4
Portland, Me.	32	9	41	Tampa, Fla.			
Providence, R. I.	46	14	60				
Louisville, Ky.	16	7	23	Total, 1918.	1,154	644	1,798
Evansville, Ind.	17	4	21	Total, 1917.	1,868	959	2,827
Memphis, Tenn.	25	6	31				
Nashville, Tenn.	18	1	19	Decrease	714	315	1,029

MARINE-BOILER PLATES TESTED.

During the year ended June 30, 1918, 9,605 marine-boiler plates were tested at the mills by assistant inspectors of this Service, under act of Congress, approved January 22, 1894. Of this number, 9,153 were accepted and 452 were rejected, as follows:

Inspected by assistant inspector—	Plates rejected because of—														Total.		
	Spilled as shears after inspection.	Lost in shipping house.	Tensile strength.	Elongation.	Lamination.	Light gauge.	Surface defects.	Excessive plates.	Spilled in flanging after inspection.	Heavy gauge.	Analysis.	Bending test.	No ring marks on plates.	Excessive sulphur.	Rejected.	Accepted.	Inspected.
J. N. J. Seltzer, Coatesville, Pa.	8	18	18	2	12	18	97	6							179	2,485	2,664
E. G. Allen, Coatesville, Pa.	1	1	4		4	3	1	1							15	433	448
J. B. Hayward and J. W. Kidney, at Pittsburgh, Pa.	1		7		9	53	21		1			9			101	1,402	1,503
J. T. Farnham, Chicago, Ill.	2		3	9	14	2	50						2		82	708	790
W. Greenwood, Chicago, Ill.	1	2	3		1	1									8	132	140
S. A. Mills, Philadelphia, Pa.		1	1				6					2			10	434	444
A. C. Brockner, Cleveland, Ohio.			1		34		19					2			56	3,311	3,367
R. B. Huston, Cleveland, Ohio.					1										1	223	224
E. D. Butler, Cleveland, Ohio.																25	25
Total, 1918.....	13	22	37	14	75	77	194	7	1	1		13	2		452	9,153	9,605
Total, 1917.....	4	13	52	19	23	7	39	8	3	2	2	1	1	1	175	3,434	3,609
Increase (+) or decrease (—).....	+9	+9	-15	-8	+52	+70	+155	-1	-3	-1	-2	+12	+1	-1	+277	+5,719	+5,996

NEW LIFE PRESERVERS INSPECTED.

During the fiscal year inspectors of this Service inspected new life preservers as follows:

Kind.	Passed.	Rejected.	Inspected.
Block cork	213,481	2,820	216,301
Tule	4,300		4,300
Compressed cork	85		85
Balsa wood (A B C)	211	60	271
Manasilk	95,708	2,594	98,302
Total, 1918.	313,785	5,474	319,259
Total, 1917.	201,224	1,359	202,583
Increase	112,561	4,115	116,676

In addition to the life preservers inspected as shown above, 23,184 cork ring buoys were inspected, 20,139 of which were passed and 3,045 were rejected.

OFFICERS LICENSED.

There were 32,458 officers of all grades licensed during the fiscal year ended June 30, 1918. The number licensed for each grade, by local districts, is shown in the following table:

Local district.	Masters of steam vessels.	Masters of ocean yachts.	Mates of ocean steamers.	Mates of inland steamers.	First-class pilots.	Second-class and special pilots.	Chief engineers.	Assistant engineers.	Special engineers.	Joint pilots and engineers.	Engineers of motor vessels other than steam.	Operators of motor vessels.	Masters of sail vessels of over 700 gross tons.	Mates of sail vessels of over 700 gross tons.	Masters of barges of over 100 gross tons.	Total of all grades.
San Francisco, Cal.	396		415	54	34	24	410	455	2	1	160	450	37	7		2,445
Honolulu, Hawaii	21	22			1	1	10	10			11	19				95
Juneau, Alaska	16	6	2		5		18	3			14	132	1			197
Los Angeles, Cal.	51		151	1	2	1	43	28			24	186				487
Portland, Oreg.	105		77	28	2	12	133	53		1	38	316	4	1		770
St. Michael, Alaska	12			3	1	3	15				3	55				92
Seattle, Wash.	307		237	85	1	28	369	297	2	4	147	477	4	1		1,950
New York, N. Y.	1,254		1,079	38	223	47	1,719	1,458			146	833	34	1	2	6,534
Albany, N. Y.	62			13	46	38	174	9	2		2	47				338
New Haven, Conn.	58		4	1	20	17	57	10			23	128	1			319
Philadelphia, Pa.	218		328	13	36	50	329	252	4		39	463	5	1		1,738
Norfolk, Va.	214		140	1	57	60	263	191	6	2	27	538	2			1,501
Baltimore, Md.	156		156	29	48	43	254	141	2		34	362	4			1,239
Charleston, S. C.	51		15	1	10	13	66	48	3	2	11	123				344
Jacksonville, Fla.	64	2	27	4	11	16	74	21	2		36	354	2			613
Savannah, Ga.	39	1	19	1	8	11	54	56			16	35	1			241
St. Louis, Mo.	69		1	28	53		116	10	2		7	177				468
Dubuque, Iowa	31			3	15	9	70	13			14	134				289
Boston, Mass.	192		384	7	25	38	310	341	2		47	235	10	1		1,592
Bangor, Me.	35		71	6	9	22	48	4	4		7	149	2			357
New London, Conn.	47			2	13	5	97	15			22	109				310
Portland, Me.	97		95	2	7	9	79	20			3	154	23			489
Providence, R. I.	63		68	4	13	21	88	28	1		15	151	4			456
Louisville, Ky.	26			5	20	3	48	5			8	65				180
Evansville, Ind.	19			4	13	5	46	7			3	103				200
Memphis, Tenn.	33			1	12	9	80	2			3	137				277
Nashville, Tenn.	29			11	24	1	45	4	4		3	65				186
Pittsburgh, Pa.	99			26	10	6	105	17			2	60				325
Cincinnati, Ohio	60			24	20		70	7			2	29				213
Point Pleasant, W. Va.	50			9	17		52	8			7	89				232
Detroit, Mich.	113		24		38	8	173	69			9	55				489
Chicago, Ill.	65		86		38	16	177	206			8	143				739
Duluth, Minn.	55		6		12	9	51	8	1		1	22				165
Grand Haven, Mich.	30			1	18	33	75	11			3	215				387
Marquette, Mich.	22				14	16	57		2		1	92				204
Milwaukee, Wis.	91				91	21	157	84	1		15	97				557
Port Huron, Mich.	67				40	4	84	48	1			27				371
Cleveland, Ohio	99		27		42	20	287	156			13	61				645
Buffalo, N. Y.	71		18		55	48	211	55	1	1	2	107				596
Burlington, Vt.	6				5	9	15		1		2	49				86
Oswego, N. Y.	29				20	23	74	9	1	1	2	118				377
Toledo, Ohio	37				13	11	61	11			2	68				309
New Orleans, La.	283		149	22	55	68	314	178			87	211	2			1,378
Apalachicola, Fla.	30		5	6	10	7	42	5	2		15	212	2			336
Galveston, Tex.	57		78	16	23	15	89	87	2		49	231	9			596
Mobile, Ala.	65		41	4	25	18	98	8			18	126	13			413
San Juan, P. R.	6				5	10	9	12	1		11	26				86
Tampa, Fla.	23		21		2	3	19	10			26	120	2			236
Total, 1918.	5,022	3	3,756	455	1,262	833	7,185	4,420	55	13	138	8,135	162	12	7	32,458
Total, 1917.	4,550	5	3,684	416	1,079	662	5,955	1,779	35	16	1,191	16,133	136	13	8	26,962
Increase (+) or decrease (-)	+472	-2	+2772	+39	+183	+171	+1,230	+2,641	+20	-3	-5	-1,998	+26	-1	-1	+5,496

EXAMINATIONS FOR COLOR BLINDNESS.

During the year ended June 30, 1918, 11,715 applicants for original and renewal of licenses were examined for visual defects, 206 of whom were found color blind or had other visual defects and were rejected, and 11,509 were passed. As compared with the previous year these figures show an increase of 3,877 in the number examined and 3,732 in the number passed.

CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN.

There is submitted herewith a tabulated statement showing the number of applications received for certificates of service as able seamen, the number of applicants rejected, and the number of certificates issued during the fiscal year ended June 30, 1918.

Local inspection district.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.	Local inspection district.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.
San Francisco, Cal.	320	23	297	Duluth, Minn.	199	26	173
Los Angeles, Cal.	26	1	25	Grand Haven, Mich.	20	3	17
Honolulu, Hawaii	35	4	31	Marquette, Mich.	19	2	17
Portland, Oreg.	62	3	49	Milwaukee, Wis.	157	11	146
Seattle, Wash.	254	17	237	Port Huron, Mich.	59	6	72
New York, N. Y.	2,867	91	2,776	Cleveland, Ohio.	599	134	465
New Haven, Conn.	6	.....	6	Buffalo, N. Y.	311	22	289
Philadelphia, Pa.	360	27	333	Oswego, N. Y.	17	1	16
Norfolk, Va.	338	13	325	Toledo, Ohio.	200	9	191
Baltimore, Md.	429	26	403	New Orleans, La.	244	23	221
Charleston, S. C.	3	.....	3	Apalachicola, Fla.	44	.....	44
Savannah, Ga.	537	18	509	Galveston, Tex.	143	22	121
Jacksonville, Fla.	122	3	119	Mobile, Ala.	210	16	194
Boston, Mass.	370	20	350	San Juan, P. R.	69	4	65
Bangor, Me.	6	.....	6	Tampa, Fla.	91	.....	91
New London, Conn.	44	10	34	Total, 1918.	8,934	600	8,334
Portland, Me.	80	.....	80	Total, 1917.	14,966	1,507	13,304
Providence, R. I.	150	10	140	Decrease.	6,032	907	4,970
Detroit, Mich.	235	27	208				
Chicago, Ill.	299	28	271				

CERTIFICATES OF EFFICIENCY ISSUED TO LIFEBOAT MEN.

Herewith submitted is a statement showing the number of applications received for certificates of efficiency as lifeboat men, the number of applicants rejected, and the number of certificates issued during the fiscal year ended June 30, 1918.

By whom issued, port, vessel, etc.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.	By whom issued, port, vessel, etc.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.
Local inspectors of steam vessels:				Local inspectors of steam vessels—Continued.			
San Francisco, Cal.	248	.....	248	Jacksonville, Fla.	129	.....	129
Honolulu, Hawaii	2	.....	2	Savannah, Ga.	121	.....	121
Juneau, Alaska.	1	.....	1	Boston, Mass.	88	.....	88
Los Angeles, Cal.	59	.....	59	Bangor, Me.	9	.....	9
Portland, Oreg.	73	.....	73	New London, Conn.	137	.....	137
Seattle, Wash.	87	.....	87	Portland, Me.	4	.....	4
New York, N. Y.	2	.....	2	Providence, R. I.	92	.....	92
New Haven, Conn.	77	.....	77	Detroit, Mich.	251	.....	251
Philadelphia, Pa.	59	.....	59	Chicago, Ill.	7	.....	7
Norfolk, Va.	37	.....	37	Duluth, Minn.	3	.....	3
Baltimore, Md.	351	11	340	Grand Haven, Mich.	106	6	100
Charleston, S. C.	6	.....	6	Milwaukee, Wis.	10	.....	10

By whom issued, port, vessel, etc.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.	By whom issued, port, vessel, etc.	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.
Local inspectors of steam vessels—Continued.				Bureau of Lighthouses, Department of Commerce—Continued.			
Port Huron, Mich.....	1	.....	1	Tenders—Continued.			
Cleveland, Ohio.....	152	25	127	Manzanita.....	9	.....	9
Buffalo, N. Y.....	55	.....	55	Marigold.....	7	1	6
Oswego, N. Y.....	7	.....	7	Mistletoe.....	4	.....	4
Toledo, Ohio.....	2	.....	2	Pansy.....	6	.....	6
New Orleans, La.....	44	.....	44	Sequoia.....	21	1	20
Apalachicola, Fla.....	37	.....	37	Sunflower.....	24	8	16
Galveston, Tex.....	36	.....	36	Zizania.....	13	1	12
Mobile, Ala.....	40	3	37	United States Coast Guard, Navy Department:			
San Juan, P. R.....	12	.....	12	Cutters—			
Tampa, Fla.....	10	.....	10	Androscooggin.....	26	.....	26
U. S. Coast and Geodetic Survey, Department of Commerce:				Arcata.....	31	4	27
Steamer—Cosmos.....	2	.....	2	Bear.....	27	.....	27
Field station, New Orleans, La.....	8	.....	8	Comanche.....	28	1	27
Bureau of Fisheries, Department of Commerce:				Davey.....	6	.....	6
Steamer—Gannet.....	16	2	14	Greesham.....	21	8	13
Navy Department:				Guard.....	2	.....	2
Receiving ships at—				Hartley.....	839	215	624
Boston, Mass.....	35	.....	35	Morrill.....	1	.....	1
Philadelphia, Pa.....	57	.....	57	Ossipee.....	3	.....	3
Navy yards at—				Scout.....	10	.....	10
New York, N. Y.....	989	98	871	Seminole.....	6	.....	6
New Orleans, La.....	46	1	45	Seneca.....	8	.....	8
Norfolk, Va.....	57	.....	57	Tallapoosa.....	22	1	21
Bureau of Lighthouses, Department of Commerce:				Tuscarora.....	21	1	20
Tenders—				Unauga.....	4	.....	4
Amaranth.....	14	.....	14	Stations—			
Anemone.....	19	10	9	No. 232.....	9	.....	9
Aspen.....	1	.....	1	No. 235.....	278	203	73
Azalea.....	45	4	41	No. 237.....	72	9	63
Camelia.....	2	.....	2	No. 238.....	20	1	19
Crocus.....	1	.....	1	No. 239.....	197	60	137
Heather.....	14	.....	14	No. 240.....	11	8	3
Hibiscus.....	10	.....	10	No. 241.....	9	1	8
John Rodgers.....	10	.....	10	No. 242.....	5	.....	5
Larkspur.....	6	3	3	No. 273.....	20	10	10
Laurel.....	2	.....	2	No. 274.....	22	10	12
Lilac.....	66	14	52	No. 275.....	31	6	25
Magnolia.....	23	5	18	No. 276.....	154	45	109
Mangrove.....	3	.....	3	No. 280.....	17	3	14
				No. 285.....	2	.....	2
				No. 288.....	20	1	19
				No. 297.....	43	2	41
				No. 304.....			

The following is a summary of the certificates of efficiency as lifeboat men issued during the fiscal year ended June 30, 1918:

Issued by—	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.	Issued by—	Applica- tions re- ceived.	Applica- tions re- jected.	Certifi- cates issued.
Local inspectors of steam vessels.....	2,355	45	2,310	U. S. Coast Guard.....	2,042	583	1,459
U. S. Coast and Geodetic Survey.....	10	.....	10	Total, 1918.....	5,887	786	5,101
Bureau of Fisheries.....	16	2	14	Total, 1917.....	14,562	2,943	11,619
Bureau of Lighthouses.....	300	47	253	Decrease.....	8,675	2,157	6,518
Navy Department.....	1,164	99	1,065				

It has been impossible on account of the movement of vessels, change of officers, and other changes in connection with the prosecution of the present war to obtain full report on certificates of efficiency issued to lifeboat men and above report is, therefore, incomplete.

RECORD OF REPORTS OF CASUALTIES AND VIOLATIONS OF LAW.

Following is a statement showing the number of reports covering casualties and violations of law by vessels subject to inspection during the fiscal year ended June 30, 1918, by supervising inspection districts:

Description.	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	Total.
Fire.....	17	23	10	1	11	5	5	8	4	8	92
Collision.....	42	128	42	.....	29	5	8	62	55	17	388
Explosion or accidental escape of steam.....	5	6	4	.....	.....	2	.....	4	2	3	26
Wrecked.....	2	5	.....	.....	.....	.....	.....	1	.....	1	9
Grounding.....	33	32	20	.....	27	5	1	29	16	12	175
Foundered in storm.....	.....	8	.....	2	10	9	.....	1	2	2	34
Sinking.....	2	70	7	3	5	33	28	4	4	9	170
Accidental drowning.....	15	17	11	4	1	6	5	7	11	15	92
Suicide.....	9	5	.....	1	1	1	.....	3	3	5	28
Miscellaneous.....	47	81	15	4	17	27	27	72	45	16	301
Violations of law.....	17	129	59	4	40	21	6	26	144	106	552
Total, 1918.....	189	454	168	24	141	114	80	217	286	194	1,867
Total, 1917.....	213	396	187	56	200	120	54	274	289	251	2,040
Increase (+) or decrease (-)	-24	+58	-19	-32	-59	-6	+26	-57	-3	-57	-173

LIVES LOST ON VESSELS SUBJECT TO INSPECTION.

Following is a statement showing the loss of life on vessels subject to inspection during the fiscal year ended June 30, 1918, divided as to passengers and crew, by supervising inspection districts and by causes:

Supervising inspection district.	Fire.	Collision.	Explosions, escape of steam.	Wrecked.	Foundered in storm.	Sinking.	Accidental drowning.	Suicide.	Miscellaneous.	Total.
First:										
Passengers.....							1	9		10
Crew.....		8	3				14		2	27
Second:										
Passengers.....		36				8	2	5	1	52
Crew.....	3	39	36	2	13	131	15		5	244
Third:										
Passengers.....							1			1
Crew.....		2	11		1	3	10		2	20
Fourth:										
Passengers.....							1	1		2
Crew.....							3			3
Fifth:										
Passengers.....								1		1
Crew.....	2				14	9	1			26
Sixth:										
Passengers.....								1		1
Crew.....		1					6		1	8
Seventh: Crew.....		1					5		1	7
Eighth:										
Passengers.....								3		3
Crew.....	2	2	2	1	7		7		8	29
Ninth:										
Passengers.....								2		2
Crew.....						1	11	1	6	19
Tenth:										
Passengers.....							2	3		5
Crew.....		10	3		2		13	2	1	31
Total.....	7	99	55	3	37	152	92	28	27	500
Passengers.....		36				8	7		1	77
Crew.....	7	63	55	3	37	144	85	25	26	423

* 21 cases due to intoxication.

* Decrease of 92 from previous year.

The following is a statement showing the number of lives lost during the fiscal year ended June 30, 1918, on passenger and nonpassenger carrying vessels subject to inspection, from the various causes, shown by supervising inspection districts:

Cause.	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	Total.
Fire: Nonpassenger		3			2			2			7
Collision:											
Passenger		36	2				1				39
Nonpassenger	8	39				1		2		10	60
Explosions, escape of steam, etc.:											
Passenger			5								5
Nonpassenger	3	36	6					3		3	50
Wrecks: Nonpassenger		2						1			3
Foundered in storm: Nonpassenger											
Passenger		13	1		14			7		2	27
Nonpassenger		139	3		9				1		152
Accidental drowning:											
Passenger	4	3	2	3		4	2		1	8	27
Nonpassenger	11	14	9	1	1	2	3	7	10	7	65
Suicide:											
Passenger	9	5		1	1	1		3	2	4	26
Nonpassenger									1	1	2
Miscellaneous:											
Passenger		1							1		2
Nonpassenger	2	5	2			1	1	8	5	1	25
Total:											
Passenger	13	45	9	4	1	5	3	3	4	12	99
Nonpassenger	24	251	21	1	26	4	4	29	17	24	401
Grand total	37	296	30	5	27	9	7	32	21	36	500
Last year	52	257	37	11	15	21	15	45	65	74	582
Increase (+) or decrease (-).	-15	+39	-7	-6	+12	-12	-8	-13	-44	-38	-82

LIVES SAVED.

During the year the number of lives directly saved by means of the life-saving appliances required by law was 1,356.

ACCIDENTS RESULTING IN LOSS OF LIFE.

The total number of accidents resulting in loss of life during the past fiscal year was 217, a decrease of 40 from the previous year. Enumerated by supervising inspection districts, accidents occurred as follows: First, 30; second, 66; third, 20; fourth, 5; fifth, 8; sixth, 9; seventh, 7; eighth, 24; ninth, 21; tenth, 27.

The following disasters resulted in an unusually large loss of life:

On July 3, 1917, the steamer *Orleans* was torpedoed by a German submarine in latitude 47° 12' N. and longitude 7° 40' W., with the result that the vessel sank in 10 minutes, causing the loss of four of the crew.

On July 10, 1917, when the steamer *Kansan* was off Kerdonis Point, Belle Isle, France, a violent explosion occurred just abaft of engine room, with the result that the vessel sank in six and one-half minutes, causing the loss of four of the crew. The master was unable to state whether damage was caused by torpedo or by striking a mine.

On July 12, 1917, the steamer *Grace* was torpedoed by an enemy submarine in latitude 38° 11' N. and longitude 24° 41' E., vessel sinking in 12 minutes, causing the loss of three of the crew.

On July 31, 1917, the steamer *Motano* was torpedoed by an enemy submarine off Plymouth, England, causing vessel to sink in less than one minute, resulting in the loss of 24 of the crew.

On September 23, 1917, the hawser attached to the barge *Western Belle*, in tow of the steamer *Warrior*, parted during severe weather, the barge afterwards springing a leak and sinking, causing the loss of three lives.

The freight steamer *Itasca* encountered a severe gale off Bermuda, causing vessel to spring a leak. The officers and the crew abandoned the vessel with the exception of the master, who was drowned. Chief engineer was lost overboard from lifeboat, and one sailor died from exposure.

On October 5, 1917, the towing steamer *Magic* collided with the passenger steamer *Tolo* while en route from Bremerton to Seattle, Wash., with the result that the steamer *Tolo* sank in eight minutes, causing the loss of four lives.

On October 11, 1917, the freight steamer *Lewis Luckenbach* was torpedoed by an enemy submarine off the coast of France. Ten of the crew lost their lives.

On October 27, 1917, the steamer *D. N. Luckenbach* was torpedoed by an enemy submarine while en route from New York to a French port, the explosion of the torpedo killing five of the engine-room crew.

On November 2, 1917, the steamer *Rochester* was torpedoed by an enemy submarine in latitude 55° 28' N. and longitude 18° W., causing the vessel to sink rapidly, and resulting in the loss of 22 of the crew.

On November 24, 1917, the steamer *Actaeon* was torpedoed by an enemy submarine in latitude 45° 20' N. and longitude 29° 10' W., causing vessel to sink shortly afterwards, resulting in the loss of four of the crew.

On December 8, 1917, the towing steamer *Eugene F. Moran*, with three lighters in tow, foundered during a severe gale off Atlantic City, N. J., the entire crew of 13 men losing their lives.

The steamer *Desmond*, while en route from St. Joseph, Mich., to Racine, Wis., loaded with sand, was driven out of her course by a storm, and while endeavoring to enter the harbor at South Chicago, Ill., took in so much water over the side that she foundered, resulting in seven of the crew losing their lives.

The barges *Madison*, *Marion B.*, and *Chippewa*, in tow of the steamer *Charles A. McCaffrey*, foundered during an extremely severe gale off Beavertail Light, resulting in six persons losing their lives.

On December 9, 1917, the barge *Lancaster*, in tow of the steamer *Georges Creek*, foundered during a severe gale off Winterquarter Light Vessel, resulting in the entire crew of four persons losing their lives.

On January 6, 1918, the steamer *Harry Luckenbach* was torpedoed by an enemy submarine in the Bay of Biscay, with the result that the vessel sank shortly afterwards, causing the loss of four of the crew.

On January 14, 1918, the steamer *Chelsea* caught fire while lying at foot of Essex Street, Jersey City, N. J. Three of the crew, who were on board the vessel at the time, lost their lives.

On February 5, 1918, the steamer *Alamance* was torpedoed by an enemy submarine off the north coast of Ireland, with the result that six of the crew lost their lives.

On March 10, 1918, the barge *Hampshire*, in tow of the steamer *Mars*, foundered during a severe gale near Five Fathom Bank Light Vessel, the entire crew of four men being lost.

The steamer *Coahuila* collided with the towing steamer *W. A. Bisso*, about 42 miles below New Orleans, La., resulting in the sinking of the steamer *W. A. Bisso*, and the loss of nine of her crew.

On May 2, 1918, the steamer *Tyler* was torpedoed by an enemy submarine in the Mediterranean Sea, 11 of the crew losing their lives.

On May 11, 1918, the barge *Liberty*, in tow of the steamer *Ontario*, foundered about 2 miles off Vineyard Sound Light Vessel, resulting in the loss of four of the crew.

On April 5, 1918, while the passenger steamer *Annie* was lying at the dock at Elizabeth City, N. C., after having discharged her passengers, a boiler exploded, practically demolishing the vessel and killing five of the crew.

On April 17, 1918, an explosion occurred on board the steamer *Florence H.*, while that vessel was lying at anchor in Quiberon Bay, France, causing the sinking of the vessel and resulting in 43 persons losing their lives.

On May 1, 1918, the passenger steamer *City of Athens*, en route from New York to Savannah, Ga., collided with the French cruiser *La Glorie*, resulting in the sinking of the steamer *City of Athens* and causing the loss of 34 of the passengers and 32 of the crew.

On June 2, 1918, the steamer *Carolina*, while en route from San Juan, P. R., was torpedoed by an enemy submarine, resulting in the loss of eight passengers and five of the crew.

PASSENGERS CARRIED.

During the fiscal year 335,141,118 passengers were carried on steam vessels that are required by law to report the number of passengers carried. Dividing this number by 77, the total number of passengers lost, shows that 4,352,482 passengers were carried for each passenger lost. The total number of lives lost from all causes, passengers and crew, was 500.

SUMMARY OF WORK OF THE TRAVELING INSPECTORS.

The following is a statement giving a summary of the work performed by the traveling inspectors of this Service, with headquarters at New York, N. Y., and San Francisco, Cal., for the fiscal year ended June 30, 1918:

Number of vessels inspected.....	277
Gross tonnage of vessels inspected.....	386,235
Number of miles traveled in making inspections.....	17,872
Number of examinations for licenses in the ocean service held at ports on the Great Lakes.....	20
Number of licenses granted as a result of said examinations.....	202
Number of licenses refused.....	7
Number of licenses examined.....	1,277
Number of special investigations made.....	11

CHARACTER AND NUMBER OF DEFICIENCIES FOUND AND REPORTED.

Alarm bells.....	17	Ring buoys.....	2
Auxiliary lighting system.....	2	Rotary davits.....	4
Lead pan under fuel tank.....	1	Short one-fire extinguisher.....	2
Licenses.....	2	Sprinkling system.....	3
Mechanical davits.....	8	Steam pipes uncovered.....	2
Means of escape.....	1		
Receptacles for boat falls.....	1	Total.....	46
Releasing gear.....	1		

PROSECUTION OF THE WAR WITH GERMANY.

The United States is at war with the Imperial German Government. Every activity and every effort of the vast machinery of the Government is now so directed that all things are subordinated to the one idea of defeating the common enemy. The Steamboat-Inspection Service, as a part of the Department of Commerce, has the honor of occupying an important position in the prosecution of the war against Germany, and everything has been done by the Service that can be done to make it more efficient, to make it function more rapidly and accurately, and to thereby carry out more expeditiously the work that is assigned to it by law. This has been done by improving business methods of administration, by the adoption of regulations that are adjusted to war conditions, by the inspection of vessels, by the licensing of men, by investigations of alleged instances of disloyalty on the part of licensed officers, by the enactment by Congress of important legislation affecting this Service, and by the personnel of the Service serving on important committees of other branches of the Government. Each of these subjects will be spoken of briefly hereinafter.

BUSINESS METHODS.

The first essential in connection with the prosecution of the war is the avoidance of delay. Of necessity, when the United States threw itself into this great struggle all of us were in a sense finding ourselves, but it may be stated for the Steamboat-Inspection Service, without any egotism, that there has never been any delay caused by administrative methods since this war commenced. It has been found, however, that improvements could be made and short cuts taken, and this has been done. Reference to the tables in the first part of this report will show that there is an immense increase in the amount of work done by the Steamboat-Inspection Service, and that has been due, not to increased personnel commensurate with the increased amount of work, but to administrative methods. It follows, therefore, that the only way war conditions could be met was by superior administrative methods and excellent organization, and by these two means the Service has been able to keep abreast of the demands that have been made upon it. The correspondence has been exceedingly heavy, and this was to be expected, because, as more business interests gave their attention to maritime affairs, there were more persons who were desirous of obtaining information in regard to the merchant marine, and, therefore, so far as the functions of this Service are concerned, the central office has been called

upon increasingly to answer an enormous correspondence relating to these matters. These answers have usually been made the day the letters have been received. There have been, of course, many instances when telegraphic instructions had to be given, and this has been especially true of requests that have been made from time to time by the Emergency Fleet Corporation. It has been necessary at times to make rulings governing important work, and, as these rulings could be made by administrative authority, they were made without delay.

At the time of the writing of the last annual report the mind of the Nation was concerned largely in the laying of plans incident to the war, and we have now proceeded far enough to be able to see the fruition of some of those plans. Ships are being launched and are being inspected. Men are applying for examination and are being licensed. Such investigations as are necessary are being promptly conducted, and now we can feel the confidence of approaching victory, because we can see the results of the plans that have been laid. These results will become more magnificent as we proceed, and it is not too much to expect that the United States will become the first maritime power of the world. The principal thing to be guarded against in the administration of a service, especially true in war times, is to prevent congestion, and a little thought will show that, if care be not taken, congested conditions will very soon arise in the Steamboat-Inspection Service that would be hard to correct. Therefore, in order to avoid such a situation, the Bureau has from time to time ordered inspectors from one port to another to assist in the inspection of vessels. The usual congestion occurs each spring on the Great Lakes, but last spring it was handled, it is believed, better than ever before, and, with the increasing personnel, it is hoped that the time is soon approaching when it will not be necessary to take inspectors from the Atlantic coast and send them to the Lakes for inspection duty.

REGULATIONS.

There are some things that can not be adjusted by administrative authority, as exercised by the officers of the Bureau, such, for instance, as the adoption of regulations in regard to inspection and the licensing of men. Regulations have, therefore, been prescribed by the Board of Supervising Inspectors, and, when that board is not in session, by its executive committees, which committees are authorized by statute. In connection with the regulations that have been adopted I desire to call particular attention to the work of these committees. By reason of the fact that executive committees may be called we have been able to adjust ourselves to meet changing conditions, and thus avoid at all times any unnecessary delay. The regulations that have been adopted have referred, as would be expected, to the inspection of vessels, and everything has been done that could be done to insure safe conditions consistent with the prosecution of this war. It has been pointed out more than once that, in a country with the splendid industrial organization of the United States, we could very well expect to meet the demands which are made upon it for material, but that it would be a greater problem to obtain men. The regulations which have been adopted by the

Board of Supervising Inspectors with reference to the licensing of men are such now that many persons are eligible for licenses who formerly could not obtain one. In the prosecution of this war the Bureau has cooperated fully with the recruiting service of the United States Shipping Board, and everyone now believes that we can obtain a supply of licensed men sufficient to man the splendid fleet that is going into commission.

INSPECTION OF VESSELS.

Reference to the table in the first part of this report will show the increase in the number of vessels being inspected. While it is a magnificent thing to contemplate the tremendous activities of the shipyards, it is to be remembered that this activity results in an enormous increase of inspection for this Service. Vessels must be inspected, and they must be inspected without delay. Incident to such inspection the equipment must be followed up, and there is an immense amount of information which must be furnished to persons who are writing in regard to these matters. In order to keep abreast of the inspection work, it has been necessary, and will probably continue so, that inspectors must know no regular hours. They must work early and late, and, while they have not received extra compensation, it is, nevertheless, a reward they do receive when they know that in the work they are doing they are performing duties which are just as essential in the prosecution of this war as anything done by a soldier in battle.

Particular reference should be made to the increase in the quantity of steel plate presented for inspection. When it is recalled that hundreds of boilers are required for the fleet which is building, and that all of the material subjected to tensile strain used in these boilers must be inspected by this Service, it will be understood that at places where the mills are running full capacity turning out steel plate inspectors must be stationed who know no specified number of hours and whose business it is to test this plate, and this Bureau takes pride in stating that there has never been any delay on the part of the inspectors at the mills in the performance of their duties.

LICENSING OF MEN.

Brief reference has been made above to the licensing of men for the fleet now building. The licensing of these men has been facilitated by the Board of Supervising Inspectors in prescribing regulations by which persons can apply for licenses who were formerly not eligible. By detailed methods worked out by this Bureau in conjunction with the recruiting service of the United States Shipping Board, the inspectors of this Service approve the application blanks filed with the recruiting service, thereby avoiding the delay occasioned by informing a man that he has not had sufficient experience to obtain a license after he has taken a course in the schools of the recruiting service. In addition, instructions have been given to the local inspectors that, when applicants have finished courses in the schools conducted by the recruiting service but have not had sufficient practical experience, they may examine them immediately, and then, after having gained the necessary actual experience on board ships, they may return and

obtain their licenses. Licenses are not issued until this experience has been obtained. Reference has been made to this procedure in order that it may be seen that the Service has adjusted itself to war conditions, and, as a result, very excellent men are being obtained for the rapidly growing merchant marine.

The Bureau also keeps the director of the recruiting service of the United States Shipping Board informed as to the licensing of men, so that he may know exactly the extent of success of the work that is being conducted in the schools of the recruiting service. These reports are furnished bimonthly, and have proved to be very useful.

INVESTIGATIONS OF ALLEGED DISLOYALTY OF LICENSED OFFICERS.

Ever since the present war started, and especially since the United States Government became involved, the Bureau has had correspondence with the Office of Naval Intelligence of the Navy Department in regard to cases where that office had brought to the attention of the Bureau instances of alleged disloyalty on the part of persons holding licenses from this Service.

Many of these cases have occasioned considerable correspondence in the effort to locate the individuals concerning whom the reports have been made, and in every instance the local inspectors having original jurisdiction have run down all the reports and rumors that have been heard of alleged disloyalty of licensed officers. In some instances it was found, as the result of these investigations, that action was not justified against the licenses of these men, but in other cases the charges were proven and the licenses were promptly revoked. While all of this has caused an immense amount of work and a large amount of effort, it has been justified, because at a time such as this the Government can take no chances of having traitors on board American vessels, especially vessels which enter the war zone.

IMPORTANT LEGISLATION.

During the last fiscal year, by the act of Congress approved March 29, 1918, section 4472, Revised Statutes, was so amended as to provide that kerosene and lubricating oils made from refined products of petroleum, which will stand a fire test of not less than 300° F., may be used as stores on board steamers carrying passengers, under such regulations as may be prescribed by the Board of Supervising Inspectors with the approval of the Secretary of Commerce.

By the act of Congress approved June 10, 1918, provision has now been made for appeals to be taken in practically every instance to the Supervising Inspector General, and, when that officer's decision is approved by the Secretary of Commerce, the action is final. The effect of the enactment of this law will be to give the Supervising Inspector General more authority in certain instances than he possessed heretofore, and, while it will result to a certain extent in an increase of work in the central office, there will be a more centralized authority, which will result in greater efficiency.

While not occurring within the last fiscal year, reference should, however, be made at this time to the act of Congress approved July 2, 1918, increasing the pay of the inspectors of the Steamboat Inspection Service. Such a situation had arisen by reason of war

conditions that the Service faced complete disorganization had not Congress taken timely action in this matter of increased pay for inspectors. The compensation of these inspectors never had been, even in normal times, what it should have been, and at such a time as this, when tremendous demands are being made upon the personnel of the Service, it can very readily be seen that it was only a question of time when the Service would have been entirely disorganized by reason of the loss of its good men. Credit, however, should be given to those men who remained, and now with the increased pay provided, it is expected we will be able to obtain a good class of men for this most important work.

Much still remains to be done, however, in the matter of increasing the pay of the clerks of the Service. There seems to be an idea generally prevalent that any one can do clerical work, and, while it may be true that there are many persons in a country such as this where the standard of intelligence is very high who can do clerical work, it is, nevertheless, true that in this Service clerks to be thoroughly efficient must be especially trained. They must first be expert stenographers; and right here it may be stated that some are stenographers in name only. The clerks in this Service must be able to report what is equal to court proceedings, and when it is realized that we pay at this time but \$900 and \$1,000 per annum, it will be readily appreciated that we are often laughed at when asking a person if he would accept such a position at that salary. The laborer is worthy of his hire, and, since the inspectors have had their pay increased, there is just as much reason why the clerks who are working faithfully should also have their pay increased. The Service faces disorganization if this be not done, because the clerks of the local boards must be skilled workers, and the only way to retain such employees at this time is to see that they are well paid. It is our earnest hope that the bill now before Congress providing for an increase in the pay of clerks will be speedily enacted into law.

INSPECTORS SERVING ON COMMITTEES.

General reference has been made to the work of executive committees of the Board of Supervising Inspectors, which committees consist of the Supervising Inspector General and two supervising inspectors. The work of these committees, while arduous, has, nevertheless, been done by men who were already busily engaged at their regular work, but who, at the same time, did this additional labor.

The Supervising Inspector General is a member of the ship-protection executive committee of the United States Shipping Board, and as such has been called upon to give consideration to very important matters.

The supervising inspector of the second district, with headquarters at New York, N. Y., has served as a member of a committee giving attention to cast-steel anchor chains, and is also a member of a committee giving attention to standardizing motor-lifeboat construction.

The former supervising inspector of the fifth district, who has since resigned, cooperated most actively with the director of the

recruiting service of the United States Shipping Board with headquarters at Boston, Mass., in the matter of acting as supervisor of the training ships that are operated by the recruiting service.

The inspector of hulls of this Service at Baltimore, Md., is at present acting in a supervisory capacity with a committee of the United States Shipping Board which is giving attention to the matter of construction of concrete vessels.

All of the local inspectors confer with the boiler manufacturers, the manufacturers of equipment, etc., in regard to the inspection of vessels, and it must be remembered that an enormous amount of time is also consumed in receiving various persons in every office of the Service, all of which results in the officers of the Service being worked overtime, but this is being cheerfully done.

ESPRIT DE CORPS.

I would not be faithful to the employees of this Service if I did not, before closing this report, take the opportunity of expressing my appreciation of the work which they have performed. It is not only by great battalions and heavy artillery that battles are won. There may be present all of these things, and the equipment may be as perfect as possible, and yet battles are lost. Victories are not gained for the reason that there is lacking in one army the determination to win. The absence of that determination may have been due to a number of causes; but it matters not what those causes were, the fact remains that the spirit was lacking and the battle was lost. In this Service, at salaries that were not and are not now equal to that paid by private employers, the men and women employed here have performed the duties assigned to them without ostentation and without making themselves conspicuous. They have not only done this arduous work, but they have executed it well and on time, not as cattle that are driven to a task, but as intelligent men and women who have accepted and appreciated the responsibilities that rested upon them. All I can do in this report is to refer to that fact, and to say that it has been appreciated by me, and I believe that when the facts are known to the Nation it will be appreciated by the people. They have not heard of any delay by this Service. They have not heard of any friction. The fact is they have not heard of the Service at all, which, perhaps, is the best tribute that can be paid to it, because the employees have performed their duties silently and effectively. Noise in machinery is never an indication of efficiency.

APPENDIX.

There is attached hereto an appendix containing general statistics of the Service compiled from the reports of the supervising inspectors of the various districts for the year ended June 30, 1918, indicating the nature and extent of the work of the Service.*

Respectfully,

GEO. UHLER,
Supervising Inspector General.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

* Appendix is published in the pamphlet edition of the report of the Supervising Inspector General, but omitted from this volume.

REPORT
OF THE
COMMISSIONER OF NAVIGATION

789

REPORT OF THE COMMISSIONER OF NAVIGATION.*

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
Washington, October 1, 1918.

SIR: There is submitted herewith my annual report for the fiscal year ended June 30, 1918. With it are included the statistical tables in detail of the American merchant marine and American merchant shipbuilding for the fiscal year ended June 30, 1917, which for military reasons it was deemed inadvisable to publish last year. The report is now reduced to the narrowest limits compatible with statutory requirements, and is designed mainly to preserve in available form the historical continuity of the records, for present conditions are too exceptional to warrant inferences and conclusions as to the future.

The statistics in this report cover the operations of two totally distinct forces, each resulting in the building and operation of ships adapted to carry cargo and passengers, one force being the usual industrial and commercial effort to build and operate such ships as a familiar form of earning a livelihood for individuals and resulting in a mercantile marine; the other and greater force being the national determination at all costs to win decisive victories in the war against the enemies of civilization and to that end to expend without stint and without regard to pecuniary profit or loss the resources of the people on building and operating the ships needed to win those victories. The merchant marine and the agencies of transportation for war accordingly are mingled in the totals of shipping returns throughout this report, and can not readily be separated. The magnitude, however, of the national effort to win the war may be measured, perhaps, by the fact that Congress in the urgent deficiency act of June 15, 1917, and the war expenses deficiency act of October 6, 1917, authorized merchant shipbuilding to the extent of \$1,234,000,000. In 1914 the value of the entire British mercantile marine was somewhat less than \$1,000,000,000, estimated from the reports of 117 steamship companies, owning over 70 per cent of British passenger ships and over one-third of the total British tonnage.

CHANGES IN TRADE SINCE 1914.

At a glance the changes wrought by the war in our shipping sailing under registers, enrollments, and licenses is shown by the table following, which, of course, does not include many ships of similar types operated without such documents by the War and Navy Departments. In the period our total tonnage on June 30, 1918, had increased a trifle less than 2,000,000 gross tons, while that in foreign trade, to an increasing extent employed in trans-Atlantic war voyages,

* Appendixes and statistical tables referred to in the text following are printed in the pamphlet edition of the Commissioner's report, but omitted from this volume.

increased over 2,500,000. The excess, of course, has been drawn from ships in the domestic trade along our coasts or on the Great Lakes, where the tonnage is now reduced to ships too small for ocean service, too large to pass the locks of the Welland Canal, except at almost prohibitory cost in time and money of double reconstruction and the tonnage required for necessary war industries.

The following statement shows the total tonnage of the merchant vessels of the United States on June 30, 1914, before the outbreak of the war and on the corresponding date for 1915, 1916, 1917, and 1918:

June 30—	Foreign trade.	Coasting trade.		Total.
		Great Lakes.	Sea and rivers.	
1914.....	1,076,152	2,582,922	3,960,614	7,628,086
1915.....	1,871,543	2,818,000	3,090,886	8,380,429
1916.....	2,191,715	2,780,815	3,517,119	8,469,649
1917.....	2,446,399	2,709,824	3,654,814	8,811,037
1918.....	3,608,706	2,708,523	3,612,289	9,929,518

The total increase in our shipping during the year was 1,053,481 gross tons, more than double that of any previous year in our history (see statistical table 25) and a trifle over the total increases for the first three years of the war combined.

GAINS AND LOSSES DURING THE WAR.

The first year of the European war established in the United States the policy of "free ships," or the admission of foreign-built ships to American registry, for the foreign trade. The second year, ended in the summer of 1916, was a period of uncertainty, and the third year, ended in the summer of 1917, was marked by the growth of our ship-building industry under the spur of unrestricted submarine warfare. The fourth year has been characterized by the establishment in principle and gradually through the year in practice of direction by the Government of the operation of practically all of our seagoing tonnage, structurally capable of engaging in foreign trade, and by the vote by Congress of vast sums to build trading ships for the Government and to aid in constructing and operating shipyards. These factors are reflected in the following table, showing for the four years the two main sources of increase in our shipping—first, by construction; second, by transfer from foreign flags, including former German ships seized in our ports; and the two main causes of decrease—first, loss or abandonment; second, transfer from the American to foreign flags.

Year ended June 30—	Built in United States.	Lost or abandoned.	Transfer—		Net gain.
			To American flag.	From American flag.	
1915.....	225,122	211,429	523,361	18,595	518,480
1916.....	325,413	193,104	83,480	102,479	113,310
1917.....	664,479	230,630	86,355	197,370	322,534
1918.....	1,300,868	396,180	363,742	63,160	1,206,270
Total.....	2,515,882	1,031,343	1,066,938	381,604	2,159,873

STATISTICS FOR THE YEARS 1917 AND 1918.

The following table shows the geographical distribution, motive power, and material of construction, and trade of vessels of the United States and details of construction for the fiscal years 1917 and 1918:

COMPARISON OF AMERICAN MERCHANT MARINE OF 1917 AND 1918.

TOTAL MERCHANT FLEET.

Classification.	1917		1918	
	Number.	Gross tons.	Number.	Gross tons.
GEOGRAPHICAL DISTRIBUTION.				
Atlantic and Gulf coasts.....	16,246	4,749,739	16,327	5,356,976
Pacific coast.....	5,388	1,209,533	5,755	1,646,697
Northern lakes.....	3,001	2,779,067	2,989	2,797,503
Western rivers.....	1,762	132,678	1,060	123,342
Total.....	26,397	8,871,037	26,711	9,924,518
POWER AND MATERIAL.				
Sail:				
Wood.....	4,784	963,973	4,422	900,542
Metal.....	170	314,491	165	306,988
Total.....	4,954	1,278,464	4,587	1,209,536
Steam:				
Wood.....	4,872	830,174	4,283	823,823
Metal.....	2,364	5,366,361	2,534	6,313,090
Total.....	6,736	6,196,535	6,767	7,137,513
Gas:				
Wood.....	9,396	187,281	9,775	275,494
Metal.....	110	49,545	116	58,307
Total.....	9,506	236,826	9,891	333,801
Canal: Wood.....	532	59,740	519	58,598
Barge:				
Wood.....	4,441	974,048	4,705	1,051,736
Metal.....	228	125,424	242	133,355
Total.....	4,669	1,099,472	4,947	1,185,081
Grand total.....	26,397	8,871,037	26,711	9,924,518
TRADE.				
Registered:				
Sail—				
Wood.....	589	347,956	566	337,335
Metal.....	55	92,466	49	83,110
Total.....	644	440,451	615	420,445
Steam—				
Wood.....	261	89,295	269	113,084
Metal.....	435	1,068,455	657	2,750,065
Total.....	696	1,787,750	926	2,863,139
Gas—				
Wood.....	394	42,300	1,132	112,829
Metal.....	14	27,184	21	40,113
Total.....	408	69,484	1,153	152,942
Barge—				
Wood.....	1,221	127,962	1,295	151,116
Metal.....	14	10,232	24	16,364
Total.....	1,235	148,214	1,319	167,480
Total registered.....	3,483	2,446,399	4,013	3,603,706
Enrolled and licensed:				
Sail—				
Wood.....	4,195	616,017	3,856	563,207
Metal.....	115	221,996	116	225,583
Total.....	4,310	838,013	3,972	789,090

* Included in steam prior to 1915.

COMPARISON OF AMERICAN MERCHANT MARINE OF 1917 AND 1918—Continued.

TOTAL MERCHANT FLEET—Continued.

Classification.	1917		1918	
TRADE—continued.				
Enrolled and licensed—Continued.				
Steam—	Number.	Gross tons.	Number.	Gross tons.
Wood.....	4,111	740,879	3,964	710,739
Metal.....	1,929	3,667,906	1,877	3,568,685
Total.....	6,040	4,408,785	5,841	4,279,424
Gas—				
Wood.....	8,502	144,481	8,643	162,965
Metal.....	96	22,361	95	18,194
Total.....	8,598	166,842	8,738	181,159
Canal—Wood.....				
	532	59,740	519	58,568
Barges—				
Wood.....	3,220	836,066	3,410	900,619
Metal.....	214	115,192	218	116,991
Total.....	3,434	951,258	3,628	1,017,610
Total enrolled and licensed.....	22,914	6,424,638	22,696	6,320,812
Grand total.....	26,397	8,871,037	26,711	9,924,518

VESSELS BUILT DURING FISCAL YEARS 1917 AND 1918.

GEOGRAPHICAL DISTRIBUTION.				
Atlantic and Gulf coasts.....	567	351,494	708	582,000
Pacific coast.....	426	167,474	517	518,437
Northern lakes.....	147	139,336	168	215,022
Western rivers.....	157	6,185	135	5,409
Total.....	1,297	664,479	1,528	1,300,868
POWER AND MATERIAL.				
Sail:				
Wood.....	60	38,301	112	78,894
Metal.....	4	4,884	3	4,735
Total.....	64	43,185	115	83,629
Steam:				
Wood.....	78	30,016	80	37,771
Metal.....	114	431,304	229	962,547
Total.....	192	461,320	309	1,000,318
Gas:				
Wood.....	588	26,535	612	85,933
Metal.....	21	25,388	8	4,746
Total.....	609	51,923	620	90,678
Canal: Wood.....	26	3,423	32	4,191
Barges:				
Wood.....	392	98,689	437	113,989
Metal.....	14	5,939	15	8,123
Total.....	406	104,628	452	122,112
Total construction.....	1,297	664,479	1,528	1,300,868

* Included in steam prior to 1915.

* Including 1 cement steam vessel of 3,427 gross tons.

SEAGOING SHIPS OF 1,000 GROSS TONS OR OVER.

Nearly all this total of almost 10,000,000 gross tons is contributing directly or indirectly toward the prosecution of the war by maintaining transportation systems essential to the unremitting activity of domestic production upon which our armies abroad are dependent.

But much less than half of this tonnage is available for direct military purposes. In ordinary times before the war the average size of ships in trans-Atlantic trade between ports of the United States and Europe was 4,500 gross tons, with Asia, Africa, Australia, and South America considerably less. The European average was higher because the great trans-Atlantic express steamships formed so large a part of the total. At the present time when ships generally coal in the United States for the round voyage those under 1,000 gross tons, carrying less than 1,500 tons of cargo, bunker coal, and ship's stores need not be considered for trans-Atlantic trades.

The following statement shows the number and gross tonnage of seagoing vessels of the United States of 1,000 gross tons or over at the 1st of each month from the beginning of 1918:

Month.	Steam.		Sail.		Total.	
	Number.	Gross tons.	Number.	Gross tons.	Number.	Gross tons.
January 1.....	814	3,141,487	324	534,351	1,138	3,675,838
February 1.....	839	3,226,031	324	533,268	1,163	3,759,299
March 1.....	834	3,258,809	312	516,248	1,146	3,775,057
April 1.....	866	3,391,826	312	514,604	1,178	3,906,430
May 1.....	880	3,456,834	316	520,340	1,196	3,977,174
June 1.....	927	3,634,906	319	524,921	1,246	4,159,826
July 1.....	965	3,774,189	315	518,216	1,280	4,292,405
August 1.....	1,017	4,005,296	318	522,327	1,335	4,527,623
September 1.....	1,061	4,133,317	318	521,659	1,379	4,654,976
October 1.....	1,060	4,233,731	316	515,699	1,406	4,749,430

Of the total of 1,280 ships of 4,292,405 gross tons on July 1, 1918, the beginning of the current fiscal year, the United States Shipping Board owned 265 of 1,031,564 gross tons, and, in addition, held under requisition 447 of 2,341,117 gross tons, in all, 712 of 3,372,681 gross tons, so that 80 per cent of the total was Government owned or operated on Government account.

The average of 4,500 gross tons per ship in trans-Atlantic trade between the United States and Europe before the war was reached, of course, after years of experience, and the facts upon which it was based are not disturbed by the war which, however, has brought new considerations into play. When ships are required to coal here for the round voyage, larger ships are needed; but, on the other hand, nearly all the great passenger liners have been changed into troop transports, under naval control, reducing the average size of the remainder, and the destruction of large ships has compelled the resort to those of lesser tonnage. Trans-Atlantic transportation, however, is wholly a military subject and no direct facts upon it are stated in these pages. Just before the war there were 3,600 British steamships of over 4,000 gross tons each.

PROGRESS OF AMERICAN SHIPBUILDING.

Great events follow one another so swiftly and the development of forces, military and industrial, is so rapid in these times that the facts relating to ships built in the United States during the year ended June 30, 1918, will be already almost out of date when this report comes from the printer. The record of relative progress during the war is more useful. Up to 1914 our largest output was 614,216 gross tons during the fiscal year ended June 30, 1908, and

our maximum output, with all yards working at full capacity all the year, would have been about 750,000 gross tons. The annual output for years may be found in statistical table 25, near the end of this report. Shipbuilding in the United States was at its lowest stage in 17 years when the European war began, our output for the fiscal year ended June 30, 1915, amounting to only 225,122 gross tons. Under the impetus of European demands for ships to carry supplies for allied armies, intensified later by submarine losses and followed by extensive British, French, and Norwegian, as well as our own, orders for new ships, the output of our yards steadily increased and new yards began to be established. Still later the resources of the Treasury of the United States, virtually without bounds except those fixed by the physical limitations upon shipbuilding, were devoted to the industry. Perhaps the simplest and fairest way to state the growth of the industry is by the following table, showing at the end of each month from June, 1916, to October, 1918, the output of ships for the 12 months ended with the last day of that month.

GROSS TONNAGE OF MERCHANT VESSELS BUILT IN THE UNITED STATES (INCLUDING THOSE FOR FOREIGN OWNERS) AND OFFICIALLY NUMBERED DURING SUCCESSIVE 12-MONTH PERIODS BEGINNING WITH THE 12 MONTHS WHICH ENDED JUNE 30, 1916.

12 months ended—	Seagoing.						Grand total, including non- seagoing.	
	Steel.		Wood.		Total.			
	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
1916.								
June.....							1,030	247,147
July.....							1,012	261,213
August.....							1,042	296,471
September.....							1,057	424,686
October.....							1,066	476,222
November.....							1,124	527,622
December.....							1,179	555,288
1917.								
January.....							1,220	622,449
February.....							1,258	608,891
March.....							1,314	622,286
April.....							1,367	622,726
May.....							1,445	712,971
June.....	114	468,502	80	131,449	194	599,951	1,546	522,689
July.....	124	513,567	84	143,778	208	657,345	1,620	571,000
August.....	128	537,804	93	152,765	221	690,569	1,681	644,354
September.....	132	547,325	100	162,646	232	709,971	1,686	642,525
October.....	130	553,975	115	184,287	245	738,262	1,693	662,000
November.....	120	538,206	128	192,536	248	730,742	1,701	646,601
December.....	142	605,728	127	211,830	279	817,568	1,680	1,024,226
1918.								
January.....	144	607,404	137	211,626	281	819,030	1,657	1,025,496
February.....	157	682,867	146	222,723	303	905,590	1,669	1,106,093
March.....	180	789,354	153	238,051	333	997,405	1,670	1,194,127
April.....	203	845,338	157	286,496	360	1,081,836	1,668	1,278,132
May.....	232	966,850	151	219,947	383	1,186,797	1,661	1,381,369
June.....	252	1,031,976	158	215,716	410	1,247,692	1,622	1,430,793
July.....	275	1,124,086	189	274,380	464	1,398,396	1,610	1,571,572
August.....	315	1,268,452	214	354,172	529	1,622,624	1,612	1,781,379
September.....	352	1,411,144	256	465,327	608	1,876,471	1,681	2,013,284

Even this statement does not fully show the rapid development of the industry, as the shipyards, especially some of the largest on the Atlantic seaboard, have been engaged simultaneously on the largest project of naval construction in our history, covering about 900,000 tons displacement of war ships of various types. Extensive

repairs were also made on nearly 100 large German steamships which the enemy sought to damage hopelessly before they were seized by the United States.

Special causes operating often for only a few days, which are absorbed in a statement of 12 months' output, affect a statement of output by months. The following statement of the output, by months, from July, 1916, to August, 1918, contributes, however, to an understanding of the 12 months' statement.

VESSELS BUILT AND OFFICIALLY NUMBERED IN THE UNITED STATES, BY MONTHS, FROM JULY, 1916, TO OCTOBER 1, 1918, INCLUDING VESSELS BUILT FOR FOREIGN OWNERS.

Month.	Seagoing.						Nonseagoing.		Grand total.	
	Steel.		Wood.		Total.					
1916.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
July.....	4	9,826	3	1,784	7	11,610	114	19,121	121	30,731
August.....	5	22,479	5	3,168	10	25,647	114	27,121	124	52,768
September.....	5	25,552	5	2,632	10	28,184	84	10,289	94	38,473
October.....	15	37,770	7	14,238	22	52,008	95	18,234	117	70,242
November.....	20	66,420	3	2,644	23	69,073	86	21,563	109	90,636
December.....	4	18,385	2	1,266	6	19,651	81	18,205	87	37,856
Total.....	53	180,441	25	25,762	78	206,203	574	114,473	652	320,676
1917.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
January.....	10	52,082	6	6,672	16	58,754	83	14,841	99	73,595
February.....	4	18,779	5	6,777	9	25,556	63	11,448	72	37,004
March.....	6	38,553	5	5,448	11	44,001	126	15,110	137	59,111
April.....	8	44,653	11	22,570	19	67,223	145	11,822	167	79,045
May.....	11	36,086	19	33,004	30	69,090	162	22,137	192	91,227
June.....	22	97,908	9	31,216	31	129,124	196	22,877	227	152,001
Total.....	61	288,061	55	106,687	116	393,748	778	98,235	894	491,983
1918.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
July.....	14	54,891	7	14,113	21	69,004	184	20,148	205	89,152
August.....	9	46,716	14	12,155	23	58,871	152	27,171	175	86,042
September.....	9	35,073	12	12,513	21	47,586	80	28,999	101	76,585
October.....	13	44,420	22	35,879	35	80,299	87	10,386	122	90,685
November.....	19	50,660	11	10,872	30	61,532	87	15,736	117	77,268
December.....	17	85,917	16	20,611	33	106,528	52	16,053	85	122,581
Total.....	81	317,677	82	106,143	163	423,820	642	118,493	805	542,313
Total, 1917.....	142	605,738	137	211,830	279	817,568	1,420	216,728	1,699	1,034,296
1918.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
January.....	12	53,748	6	6,468	18	60,216	39	4,579	57	64,795
February.....	17	94,242	14	17,874	31	112,116	53	5,485	84	117,601
March.....	29	115,040	12	20,776	41	135,816	97	11,329	138	147,145
April.....	31	130,637	15	21,017	46	151,654	119	11,396	165	163,050
May.....	40	157,598	13	16,453	53	174,051	132	20,413	185	194,464
June.....	42	163,034	16	26,985	58	190,019	130	11,406	188	201,425
Total.....	171	714,299	76	109,573	247	823,872	570	64,608	817	888,480
1919.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
July.....	37	146,981	38	72,727	75	219,706	118	10,223	193	229,931
August.....	49	191,102	39	91,997	88	283,099	89	12,750	177	295,849
September.....	46	177,765	54	123,668	100	301,433	70	7,037	170	308,470
Total.....	132	515,848	131	288,392	263	804,240	277	30,010	540	834,250

^a Includes 1 cement vessel of 3,427 gross tons.

^b Includes 1 cement vessel of 325 gross tons.

Up to October 1 the Hog Island shipbuilding plant, with its 50 ways, had not finished any of the ships in various stages of construction, and its output, accordingly, had not begun to appear in the tables above, which are now published monthly.

For purposes of comparison the following official statement is reprinted, issued by the British Admiralty, showing the gross tonnage

of merchant vessels completed in the shipbuilding yards of the United Kingdom for each of the months named and for the 12 months' period ending with the end of that month, all ships being built in the United Kingdom of steel, except an inappreciable amount of wood (wood even for matches is scarce) and for obvious reasons, all being seagoing except a trifling amount for small rivers and harbors:

Month.	Gross tons.	12 months, gross tons.	Month.	Gross tons.	12 months, gross tons.
1917.			1918.		
June.....	169,847	833,863	January.....	58,568	1,173,953
July.....	83,073	865,147	February.....	100,038	1,194,540
August.....	102,080	928,470	March.....	161,674	1,237,515
September.....	63,150	967,185	April.....	111,533	1,279,337
October.....	148,309	1,045,086	May.....	197,274	1,406,838
November.....	158,826	1,133,386	June.....	134,159	1,431,150
December.....	112,486	1,163,474	July.....	141,948	1,490,025
			August.....	124,675	1,512,640
			September.....	144,772	1,594,262

Vessels when officially numbered are structurally complete, as a rule, and often simultaneously take out their registers or enrollments. More frequently furnishing and painting remain to be done after numbering and before registering, but this period seldom exceeds a fortnight. During the six months from January to June, 1916, inclusive, 524 vessels of 240,055 gross tons were built and officially numbered in the United States, while for the same period Lloyd's returns reported 160 ships of 238,255 gross tons launched in British yards. Since March, 1918, the output of the yards of the United States and of the United Kingdom have been about equal, and at present the output of this country leads. The maximum output of yards of the United Kingdom in peace times, according to Lloyd's returns was 612 vessels of 1,793,287 gross tons during 1913, and in the same year 688 vessels of 1,932,153 gross tons were launched. Comparative figures for foreign countries are given in Appendix F.

Several other branches of the Government have been collecting statistics of ships built in other countries, ships lost, etc., during the past year. So the facts on these matters usually carried in this report have not been assembled, or where assembled are not put in print.

ANALYSIS OF THE YEAR'S CONSTRUCTION.

During the past fiscal year 1,529 vessels of 1,300,868 gross tons were built and documented as vessels of the United States, compared with 1,300 of 664,479 gross tons during the year ended June 30, 1917. Neither figure fully represents the extent of merchant shipbuilding in the United States, because, in addition, in the fiscal year 1918, 22 vessels of 48,531 gross tons were built here for and delivered to foreign owners, and, in the fiscal year 1917, 40 vessels of 134,895 gross tons were built for and delivered to foreign owners.

The fiscal year has been a period of transition from the construction of ships for private account by private industry to the construction of ships, to be paid for from the Treasury of the United States, by the shipbuilding industry directed in most of its activities to a greater or less extent by Government agencies and aided in various directions by grants from the Public Treasury. The year opened with the former

system of construction in full operation, and maintained to a great extent by contracts being fulfilled for our British and French allies and for Norwegian owners. On July 1, 1917, the 43 steel shipyards in operation were building or under contract to build 499 steel ships aggregating 1,896,522 gross tons, of which 426 of 1,578,497 gross tons were to be launched—not necessarily completed—during the fiscal year. (See details at end of this volume.) At the same time the wooden shipyards were building or under contract to build 172 wooden vessels of 245,763 gross tons. These figures do not include the contracts of the Shipping Board under the system of Government ownership.

Out of the total of 1,578,497 gross tons of steel ships to be launched for private owners 250 of 935,831 gross tons were completed and registered or enrolled during the past fiscal year, the Shipping Board, in the name of the United States, taking title by requisition to nearly all of those building for British, French, or Norwegian owners, only 13 steel ships of 39,042 gross tons being delivered to their foreign owners.

The total of 245,763 gross tons of wooden ships, each over 500 gross tons, building or ordered for private owners on July 1, 1917, has been exceeded by the total of 318,048 gross tons of wooden ships of all sizes built under private contract during the fiscal year.

The building of merchant ships on Government account, which up to October, 1917, Congress had authorized to the extent of nearly one and one-quarter billions of dollars, necessarily awaited the completion of ships already partly built in existing yards or the establishment of new yards, of which the Hog Island plant is the most notable example. During the fiscal year accordingly only 18 steel ships of 83,412 gross tons were built and registered or enrolled under building contracts of the Shipping Board and only 4 wooden vessels of 12,108 gross tons under such contracts. The full effect accordingly of the policy established by Congress and of the appropriations to execute it will appear during the current fiscal year, when the private contracts will all have been fulfilled and deliveries under Government contracts will increase rapidly.

The work of the year may be set forth concisely in the following table, showing the gross tonnage of ships built and documented during the year, together with those built and delivered to foreign owners for foreign registry:

	Steel.		Wood.		Total.	
	Number.	Gross tons.	Number.	Gross tons.	Number.	Gross tons.
Private contracts.....	237	806,789	1,260	308,559	1,506	1,205,348
Shipping Board contracts.....	18	83,412	4	12,108	22	95,520
For foreign registry.....	13	39,042	9	9,489	22	48,531
Total.....	268	1,019,243	1,282	330,156	1,550	1,349,399

This brief statement of results is far from a complete statement of the extent to which the usual practice in peace times of building ships for private owners at their expense and for their trade and profit was superseded during the year by the policy of building ships

at the public expense to win the war. The range of ships just reckoned as private contracts extends from ships built and paid for wholly under the ordinary commercial system to those where only the private contract on paper existed on July 1, 1917, and the ship from the laying of the keel up to the issue of its registry was paid for step by step from the public funds and, in fact, as truly represents the war activities of the Government as do the ships built under Shipping Board contracts. Between these extremes most of the ships in the following statement are the product to varying extents of the expenditure of the public funds. The details of such expenditures, showing more accurately the extent to which the system for war purposes has superseded the mercantile system of peace times will doubtless be set forth in the reports of the Shipping Board.

SHIPS OF 1,000 GROSS TONS OR OVER BUILT DURING THE YEAR.

The salient features of the year's American construction appear from the following table of vessels of 1,000 gross tons or upward built and documented during the year, the asterisk (*) denoting tank ships for oil in bulk and (p) standing for passenger ship, the remainder being cargo boats; (s b) represents Shipping Board contracts; (b) British contracts; (d) Danish contracts; (f) French contracts; (n) Norwegian contracts; the ships under these contracts in all such cases having been requisitioned by the Shipping Board and put under American register, this table not including ships built in the United States and put under foreign register. These 332 ships of 1,207,070 gross tons, aggregate 92 per cent of the total construction of the year.

Name of vessel.	Gross tons.	Where built.	Name of vessel.	Gross tons.	Where built.
SEABOARD.			SEABOARD—CON.		
<i>Steel steamers.</i>			<i>Steel steamers—Con.</i>		
W. C. Teagle*.....	10,677	Sparrows Point, Md.	Frederic R. Kellogg*.....	7,005	Oakland, Cal.
Fred W. Weller*.....	10,626	San Francisco, Cal.	Trontolite*.....	6,832	Seattle, Wash.
A. C. Bedford*.....	10,614	Do.	William Green*.....	6,784	Philadelphia, Pa.
O. B. Jennings*.....	10,289	Newport News, Va.	Sabine Sun*.....	6,728	Chester, Pa.
J. C. Donnell*.....	10,241	Do.	Chester Sun*.....	6,669	Do.
Ampetco*.....	8,301	Sparrows Point, Md.	Virginia*.....	6,066	Quincy, Mass.
Walter A. Luckenbach.	8,286	Seattle, Wash.	Maine.....	6,457	Bath, Me.
H. M. Flagler*.....	8,207	Newport News, Va.	Rhode Island.....	6,457	Do.
Katrina Luckenbach.	8,074	Quincy, Mass.	George W. Barnes*.....	6,450	Quincy, Mass.
K. I. Luckenbach.....	8,074	Do.	Santa Olivia.....	6,421	Philadelphia, Pa.
F. J. Luckenbach.....	8,074	Do.	West Lianga (s b).....	6,222	Seattle, Wash.
Liberator.....	7,951	Alameda, Cal.	Yellowstone (n).....	6,171	Oakland, Cal.
Gulf of Mexico*.....	7,807	Camden, N. J.	Yosemite (n).....	6,149	Do.
Sylvan Arrow*.....	7,797	Do.	West Durfee (s b).....	6,087	Seattle, Wash.
Broad Arrow*.....	7,796	Do.	Fresno (b).....	6,002	Oakland, Cal.
Lancaster (b).....	7,693	Chester, Pa.	Oakland (b).....	6,002	Do.
Radnor (b).....	7,693	Do.	Pasadena (b).....	6,002	Do.
Orizaba (p).....	7,652	Philadelphia, Pa.	Coronado (b).....	5,957	Do.
Siboney (p).....	7,652	Do.	Accomac (s b).....	5,928	Los Angeles, Cal.
Deepwater.....	7,610	Camden, N. J.	Wakulla (s b).....	5,928	Do.
Wilhelm Jebsen (n)*.....	7,204	San Francisco, Cal.	Western Chief.....	5,897	Portland, Oreg.
Paul H. Harwood*.....	7,192	Do.	Western Ocean (i).....	5,890	Do.
S. M. Spalding*.....	7,175	Do.	Western Queen (n).....	5,833	Seattle, Wash.
W. M. Burton*.....	7,170	Alameda, Cal.	West Arrow (n).....	5,832	Do.
W. M. Irish*.....	7,169	Do.	Westlake (n).....	5,832	Do.
Cubore.....	7,151	Sparrows Point, Md.	Westhampton (b).....	5,832	Portland, Oreg.
J. E. O'Neil*.....	7,150	San Francisco, Cal.	Westland (n).....	5,832	Do.
Herbert L. Pratt*.....	7,145	Alameda, Cal.	Western Wave (n).....	5,832	Do.
Feltore.....	7,117	Sparrows Point, Md.	Westshore (b).....	5,831	Do.
Santoro.....	7,117	Do.	Western City (s b).....	5,828	Do.
			West Indian (s b).....	5,828	Do.
			West Bridge (b).....	5,818	Seattle, Wash.

Name of vessel.	Gross tons.	Where built.	Name of vessel.	Gross tons.	Where built.
SEABOARD—contd.			SEABOARD—contd.		
<i>Steel steamers—Con.</i>			<i>Steel steamers—Con.</i>		
West Grove (b).....	5,815	Portland, Oreg.	Silverado.....	2,328	Long Beach, Cal.
Westward Ho (b).....	5,814	Do.	Point Loma (n).....	2,119	Portland, Oreg.
West Wind (n).....	5,814	Do.	Point Arena (n).....	2,117	Do.
Western Sea (b).....	5,813	Seattle, Wash.	W. M. Tupper.....	1,852	Jacksonville, Fla.
Westgate (b).....	5,799	Portland, Oreg.	Mexoil*.....	1,370	Violet, La.
Westboro (b).....	5,769	Seattle, Wash.			
Westover (b).....	5,769	Do.	Total vessels	813,882	
Westbrook (n).....	5,748	Portland, Oreg.	(145).		
Nikkosan Maru (f).....	5,742	Seattle, Wash.			
Avondale (b)*.....	5,731	Chester, Pa.	<i>Wooden steamers.</i>		
Westchester (b).....	5,725	Portland, Oreg.	Wascó (s b).....	3,044	Portland, Oreg.
Overbrook (b)*.....	5,724	Chester, Pa.	North Bend (s b)...	3,024	North Bend, Oreg.
Jeannette Skinner	5,715	Seattle, Wash.	Biloxi (s b).....	3,021	Portland, Oreg.
(n).....			Quidnic (s b).....	3,019	North Bend, Oreg.
Westerner (n).....	5,699	Do.	Catherine D.....	2,224	Bellingham, Wash.
West Haven (b).....	5,699	Do.	Hollywood.....	1,940	Do.
West Point (b).....	5,676	Do.	Rosewood.....	1,929	Do.
Westfield (b).....	5,666	Do.	Sarah Weems.....	1,521	Solomons, Md.
Western King (b).....	5,659	Do.	City of Houston	1,519	Orange, Tex.
Westerly (b).....	5,615	Do.	(Ga. s.).....		
West Eagle (b).....	5,614	Do.	Col. Bowie.....	1,363	Westlake, La.
Westwood (b).....	5,612	Do.	Fred Baxter.....	1,294	North Bend, Oreg.
Westmount (f).....	5,584	Do.	Claremont.....	1,291	Houquiam, Wash.
W. H. Tilford*.....	5,579	Wilmington, Del.	Anyox.....	1,287	Winslow, Wash.
Ossineke (s b).....	5,577	Seattle, Wash.	Horace X. Baxter.....	1,241	North Bend, Oreg.
Canoga (s b).....	5,575	Do.	Maple.....	1,098	Shidell, La.
West Alsek (s b).....	5,573	Do.	H. B. Lovejoy.....	1,067	Seattle, Wash.
West Apaum (s b).....	5,573	Do.	Ernest H. Meyer.....	1,057	Astoria, Oreg.
Absaroka (s b).....	5,568	Do.			
Seattle (s b).....	5,564	Do.	Total vessels	30,939	
Glen White.....	5,438	Camden, N. J.	(17).		
Sewalls Point.....	5,431	Do.	<i>Metal schooners.</i>		
Fairmont.....	5,400	Do.	Monongahela.....	1,677	Fairfield, Md.
Gulfland*.....	5,276	Do.	Susquehanna.....	1,381	Mobile, Ala.
El Almirante.....	5,216	Newport News, Va.			
El Capitan.....	5,216	Do.	Total vessels	3,058	
Munaires.....	5,095	Do.	(2).		
Munindies.....	5,095	Do.	<i>Wooden schooners.</i>		
Sudbury.....	5,075	Chester, Pa.	Santa Flavia.....	2,133	Aberdeen, Wash.
Cape Henry (b).....	4,992	Sparrows Point, Md.	Rose Mahony.....	2,051	Benicia, Cal.
Cape Román (b).....	4,992	Do.	St. Johns, New	2,046	Bath, Me.
Santa Luisa (p).....	4,944	Philadelphia, Pa.	Foundland.....		
Santa Ana (p).....	4,942	Do.	Samuel W. Fancher	1,972	Do.
John M. Connally*.....	4,939	Gloucester, N. J.	Dunham Wheeler.....	1,926	Do.
Chestnut Hill (b)*.....	4,935	Do.	Edna Christenson.....	1,900	Wilmington, Cal.
Hatteras (b).....	4,919	Sparrows Point, Md.	C. A. Smith.....	1,754	North Bend, Oreg.
Sagaland (n).....	4,865	Oakland, Cal.	Ohio.....	1,677	Fairfield, Md.
Bramerton (n).....	4,856	Seattle, Wash.	Levi W. Ostrander.....	1,638	Tacoma, Wash.
Sacramento (n).....	4,856	Do.	Betsy Ross.....	1,630	Do.
Sutherland (f).....	4,855	Do.	Osceola.....	1,621	Bath, Me.
Vittorio Emmanu- ele III.....	4,855	Do.	Thistle.....	1,586	St. Helens, Oreg.
Pasale (b) (r).....	4,451	Shooters Island, N. Y.	Augusta G. Hilton.....	1,562	Thomaston, Me.
Monsieine (n) (r).....	4,444	Do.	Ella Pierce Thurlow.....	1,505	Rockland, Me.
Jupiter (f).....	4,430	Do.	Diris.....	1,491	Portland, Oreg.
Walter D. Munson.....	4,388	Sparrows Point, Md.	Richard T. Green.....	1,467	Chelsea, Mass.
Elmor (f).....	4,295	Baltimore, Md.	Commack.....	1,446	Wilmington, N. C.
Luella (b) (r).....	4,152	Do.	Hauptauge.....	1,446	Do.
Polar Sea.....	4,120	Do.	Conqueror.....	1,395	Rolph, Cal.
Redondo (n).....	4,113	Alameda, Cal.	Jessie G. Noyes.....	1,376	Thomaston, Me.
Mangore.....	4,066	Sparrows Point, Md.	Annapolis.....	1,371	Wilmington, Del.
Faith (cement).....	3,427	Redwood City, Cal.	Providence.....	1,371	Do.
Abecon.....	3,372	Camden, N. J.	Myron C. Taylor.....	1,359	Brunswick, Ga.
Tuckahoe.....	3,372	Do.	William Taylor.....	1,358	Do.
Freeman.....	3,350	Do.	Chaska.....	1,347	Savannah, Ga.
William Isom*.....	3,321	Baltimore, Md.	Harry G. Deering.....	1,342	Bath, Me.
Joseph Cudahy*.....	3,302	Do.	Charles H. Macdow- ell.....	1,325	Jacksonville, Fla.
Biran.....	2,873	Wilmington, Del.	DeWitt Brown.....	1,325	Do.
Garibaldi.....	2,873	Do.	Northern 29.....	1,267	South Jacksonville, Fla.
Guaro.....	2,873	Do.	Margaret Throop.....	1,264	Thomaston, Me.
Saetia.....	2,873	Do.	Northern No. 30.....	1,264	South Jacksonville, Fla.
Olean.....	2,783	Do.	Blue Peter.....	1,234	Camden, Me.
Point Bonita (d).....	2,575	Portland, Oreg.	Luther Little.....	1,234	Somerset, Mass.
Point Lobos (d).....	2,570	Do.			
Piqua (b).....	2,585	Wilmington, Del.			
Waukesha (b).....	2,585	Id.			
Mineola.....	2,576	Camden, N. J.			
Santa Tecla.....	2,576	Do.			
Mariners Harbor (b).....	2,431	Port Richmond, N. Y.			
Sung Harbor (b).....	2,388	Do.			

Name of vessel.	Gross tons.	Where built.	Name of vessel.	Gross tons.	Where built.
SEABOARD—contd.			GREAT LAKES—CON.		
<i>Wooden schooners—Continued.</i>			<i>Steel steamers, ocean trade—Continued.</i>		
Smith & Terry No. 1	1,156	Bethel, Del.	Lake Yemasee.....	2,319	Chicago, Ill.
Isabel C. Harriss....	1,078	Wilmington, N. C.	Lake Allen (b).....	2,308	Ecorse, Mich.
A. H. Olwine.....	1,077	Westlake, La.	Lake Crystal (b)....	2,308	Do.
Francis J. McDonald	1,059	Noank, Conn.	Lake Elizabeth (n)...	2,308	Do.
Anna Laura McKenney.	1,021	Boothbay Harbor, Me.	Lake Hemlock (b)....	2,308	Do.
Trenton.....	1,016	Baltimore, Md.	Lake Houghton (b)...	2,308	Do.
Tioga.....	1,012	Do.	Lakehurst (b).....	2,308	Do.
Total vessels (40).....	58,099		Lake Owens (b).....	2,308	Do.
<i>Wooden gasoline vessels.</i>			Lake St. Clair (b)....	2,308	Do.
Mount Hood.....	2,909	Portland, Oreg.	Lake Winona (b)....	2,308	Do.
Mount Shasta.....	2,904	Do.	Lake Conesus (b)....	2,292	Do.
Fanstrand.....	2,557	Aberdeen, Wash.	Lake Mary (b).....	2,292	Do.
Wergeland.....	2,457	Olympia, Wash.	Lake Louise (b).....	2,242	Ashtabula, Ohio.
General Pershing....	2,450	Do.	Lake Maurepas (b)...	2,242	Do.
Korsmaes.....	2,446	Do.	Lake Charlotte (b)...	2,239	Do.
Marie De Ronde.....	2,415	Aberdeen, Wash.	Lake St. Regis (b)...	2,238	Do.
Balestrand.....	2,403	Do.	Lake Annette (n)....	2,177	Manitowoc, Wis.
Mount Rainier.....	2,397	Do.	Lake Lida (n).....	2,177	Do.
Hjelteneas.....	2,387	Do.	Lake Shawano (n)....	2,177	Do.
Grays Harbor.....	2,373	Do.	Lake Pewaukee (b)...	2,167	Do.
Santa Christina.....	2,359	Do.	Lake Washburn (n)...	2,121	Superior, Wis.
City of St. Helens....	2,335	St. Helens, Oreg.	Choctaw.....	2,086	Chicago, Ill.
James Timpson.....	2,016	Portland, Oreg.	War Banner (b).....	2,080	Do.
City of Beaumont....	2,014	Orange, Tex.	War Hound (b).....	2,080	Do.
City of Mobile.....	1,975	Do.	Lake Clear (b).....	2,054	Do.
Santa Isabel.....	1,969	Hoquiam, Wash.	Lake Crescent (b)...	2,054	Do.
Asta.....	1,965	Noank, Conn.	War Chant (b).....	2,046	Superior, Wis.
City of Gulfport.....	1,844	Orange, Tex.	War Signal (b).....	2,046	Do.
Libby Maine.....	1,811	Vancouver, Wash.	Kiowa.....	2,039	Cleveland, Ohio.
Pauline.....	1,750	Astoria, Oreg.	War Penguin (b)....	2,028	Do.
May.....	1,745	Do.	Lake Capens (b)....	2,026	Superior, Wis.
Oronite.....	1,704	Benicia, Cal.	War Finch (b).....	2,020	Cleveland, Ohio.
La Merced.....	1,696	Do.	War Raven (b).....	2,020	Do.
Oregon.....	1,629	Seattle, Wash.	Lake Benton (b)....	2,018	Lorain, Ohio.
Remittent.....	1,616	Do.	Lake Como (b).....	2,018	Do.
Carmen.....	1,610	Astoria, Oreg.	Lake Weir (b).....	2,018	Do.
Risor.....	1,604	Seattle, Wash.	Lake Catherine.....	2,016	Toledo, Ohio.
Esperanza.....	1,601	Portland, Oreg.	Lake Otisco (b)....	2,015	Cleveland, Ohio.
Portland.....	1,594	Seattle, Wash.	Lake Charles (b)....	2,013	Lorain, Ohio.
Evelyn.....	1,584	Astoria, Oreg.	Lake Fernwood (b)...	2,013	Do.
Erris.....	1,582	Portland, Oreg.	Lake Harney.....	2,013	Do.
Suzanne.....	1,431	Aberdeen, Wash.	Lake Jessup (b)....	2,013	Do.
Sherewog.....	1,353	Savannah, Ga.	Lake Ordgen (b)....	2,013	Do.
Total vessels (34).....	68,085		Lake Wilmico.....	2,013	Do.
<i>Wooden barge.</i>			Lake Cayuga (b)....	2,010	Toledo, Ohio.
Northern No. 11....	1,041	Solomons, Md.	Lake Chelan (b)....	2,010	Toledo, Ohio.
GREAT LAKES.			Lake Sebago (b)....	2,010	Do.
<i>Steel steamers, ocean trade.</i>			Lake Sunapee (b)....	2,009	Do.
S. N. A. 4 (f).....	3,819	Ecorse, Mich.	Lake Tulare (b)....	2,005	Superior, Wis.
Souk Ahras (f).....	3,819	Do.	War Castle (b).....	2,003	Manitowoc, Wis.
War Path (b).....	2,534	Wyandotte, Mich.	War Victor (b).....	2,003	Do.
Perregaux (f).....	2,486	Ashtabula, Ohio.	Lake Portage (f)....	1,998	Duluth, Minn.
Sidi Mabrouk (f)....	2,485	Do.	Lake Traverse (b)...	1,993	Do.
Fagerford (n).....	2,396	Ecorse, Mich.	Maski (n).....	1,985	Do.
Lake Daraga.....	2,371	Wyandotte, Mich.	War Bayonet (b)....	1,977	Toledo, Ohio.
Lake Edop (s b)....	2,371	Cleveland, Ohio.	War Rifle (b).....	1,977	Do.
Lake Ennis (s b)....	2,371	Wyandotte, Mich.	War Shell.....	1,977	Do.
Lake Larga (s b)....	2,371	Do.	Lake Arthur (b)....	1,948	Wyandotte, Mich.
Lake Lasang (s b)...	2,371	Do.	War Beaver (b).....	1,948	Do.
Lake Lemando (s b)...	2,370	Cleveland, Ohio.	Lake Butler (b)....	1,948	Do.
Lake Ledan.....	2,369	Superior, Wis.	Lake Conway (b)....	1,948	Do.
Lake Duncan.....	2,367	Cleveland, Ohio.	Lake Duane (b).....	1,948	Do.
Lake Narks (s b)...	2,367	Do.	Lake Felicity (b)....	1,948	Do.
War Leader (b).....	2,364	Ecorse, Mich.	War Fox (b).....	1,948	Do.
			Lake Stirling (b)....	1,948	Do.
			Lake Weston (b)....	1,948	Do.
			War Honour (b)....	1,948	Do.
			Total vessels (83).....	190,865	
			<i>Steel gas, ocean trade.</i>		
			Ada (n).....	2,124	Manitowoc, Wis.
			Motor I (n).....	2,124	Do.
			Total vessels (2).....	4,248	

Name of vessel.	Gross tons.	Where built.	Name of vessel.	Gross tons.	Where built.
GREAT LAKES—CON.			WESTERN RIVERS.		
<i>Steel steamers, Lake trade.</i>			<i>Steel barge.</i>		
August Ziesing.....	8,271	Duluth, Minn.	Mammoth.....	1,392	Ambridge, Pa.
Midvale.....	8,271	Ashtabula, Ohio.			
Carnal A. Thompson	7,038	Lorain, Ohio.	Grand total		
Louis W. Hill.....	7,038	Lorain, Ohio.	(332 vessels)	1,207,070	
William A. Amberg	7,031	Do.			
William P. Cowan..	5,429	Do.			
Total vessels (6).....	43,078				
<i>Wooden steamer, ocean trade.</i>					
Sturgeon Bay.....	2,383	Sturgeon Bay, Wis.			

SUMMARY AND TYPES OF SHIPS OF 1,000 GROSS TONS BUILT.

This tonnage was built for salt water except the six large Great Lake steamers of 43,078 gross tons, and nearly all of it for the foreign trade. According to place of build and type of vessel the ships above may be thus summarized:

Type.	Seaboard.		Great Lakes.		Total.	
	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
Steel steamers.....	145	813,882	83	180,865	228	994,747
Wooden steamers.....	17	30,939	1	2,383	18	33,322
Steel schooners.....	2	3,058			2	3,058
Wooden schooners.....	40	58,099			40	58,099
Wooden gasoline.....	34	68,085			34	68,085
Steel gasoline.....			2	4,248	2	4,248
Steel barges.....					1	1,392
Wooden barges.....	1	1,041			1	1,041
Lake steel steamers.....			6	43,078	6	43,078
Total.....	239	975,104	92	230,574	332	1,207,070

^a Built on western rivers.

The original contracts for these vessels may be classed as follows, though all are now documented as vessels of the United States:

Contracts.	Seaboard.		Great Lakes.		Total.	
	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
Shipping board contracts.....	12	69,191	6	14,221	18	83,412
Private contracts:						
American.....	165	586,590	19	71,279	185	659,261
British.....	35	186,782	55	115,126	90	301,908
French.....	6	30,775	5	14,607	11	45,382
Norwegian.....	19	98,091	7	15,341	26	114,432
Danish.....	2	2,675			2	2,675
Total private.....	227	905,913	86	216,353	314	1,123,658
Grand total.....	239	975,104	92	230,574	332	1,207,070

^a Including 1 of 1,392 gross tons on western rivers.

The following summary of the vessels named in the preceding table and of vessels of 1,000 gross tons or over built each fiscal year from the beginning of the war shows the changes in the larger forms of construction:

Type	1914		1915		1916		1917		1918	
	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.	No.	Gross tons.
Seaboard:										
Ocean steel steamers.....	29	133,234	18	111,625	35	187,128	47	300,290	145	812,882
Ocean steel gas screws.....							4	13,000		
Steel ferryboats, river and bay steamers.....			1	1,402	2	3,362	3	5,363		
Wooden steamers.....	1	1,008	1	5,373	1	1,103	13	17,600	17	26,000
Wooden gas screws.....							9	15,121	34	68,085
Steel schooners.....							1	1,432	2	3,058
Wooden schooners.....	4	6,462	1	1,318	7	11,286	14	20,212	40	58,000
Wooden barkentines.....							1	1,220		
Steel unrigger vessels.....	1	1,506								
Wooden unrigger vessels.....							1	1,857	1	1,041
Total.....	35	142,200	21	119,718	45	202,579	93	375,004	230	975,104
Great Lakes:										
Steel steamers, Lake trade.....	8	37,780	1	6,331	5	26,876	14	94,715	6	42,075
Steel steamers, ocean trade.....	3	7,459	1	1,815	6	10,915	10	21,790	83	128,865
Steel gas screws, ocean trade.....							6	11,793	2	4,348
Steel schooner barges, ocean trade.....							1	2,320	1	2,388
Total.....	11	45,239	2	8,146	11	37,791	31	130,618	92	280,574
Western Rivers:										
Steel gas screws.....					1	1,473				
Steel barge.....									1	1,362
Grand total.....	46	187,448	23	127,864	57	242,145	124	506,222	333	1,255,678

WOODEN SHIPBUILDING.

The great demand and high prices of steel and the urgent need of ships have restored to operation wooden shipyards virtually abandoned or idle for years and have led to the establishment of some new yards.

The growth of wooden shipbuilding for American and foreign owners may be followed in the foregoing tables, bearing in mind that the greater part of nonseagoing tonnage is built of wood, tonnage of steel vessels each under 1,000 gross tons built in the past year comprising only 35 vessels of 9,057 gross tons. For the fiscal year 1916 the wooden vessels built numbered 788 of 86,641 gross tons, for the following fiscal year 1,150 of 197,250 gross tons, and for the year ended June 30, 1918, they numbered 1,275 of 320,667 gross tons.

CONSTRUCTION DURING THE CURRENT FISCAL YEAR.

For the duration of the war, and probably for at least two years, the greater amount of shipping to be built in American yards will be built with public funds under contracts made by the Shipping Board. For this reason the statement of steel ships under construction or under contract at the beginning of the fiscal year is not issued and the returns on which it has been based in other years have not been requested. Whether or not there will be a return to mercantile ship-

building by individual enterprise and when, if ever, it will come about are questions the discussion of which is not pertinent to winning the war.

To show the development of steel shipbuilding in the United States under the mercantile system from 1900 up to the beginning of the fiscal year on July 1, 1917, the usual summary is printed for future reference, and the statement in detail of steel ships building or under contract on July 1, 1917, not published last year, is printed at the end of this report with other tables for 1917 not printed at the time.

COMPARISON OF STEEL VESSELS BUILDING IN THE UNITED STATES, 1900-1917.

Date.	Merchant.						Government.		Total.	
	Great Lakes, etc.		Seaboard.		Total.					
	No.	Gr. tons.	No.	Gr. tons.	No.	Gr. tons.	No.	Tons.	No.	Tons.
August 15, 1900.....	20	70, 119	48	207, 561	68	277, 680	47	113, 329	115	391, 009
June 15, 1901.....	26	81, 780	63	273, 865	89	355, 645	71	281, 148	160	636, 793
July 1, 1902.....	39	124, 537	65	222, 949	104	347, 486	67	269, 890	171	617, 376
July 1, 1903.....	30	109, 020	58	146, 655	88	255, 675	47	334, 147	135	589, 822
July 1, 1904.....	1	400	56	94, 558	57	94, 968	38	331, 435	95	426, 423
July 1, 1905.....	27	104, 067	49	86, 836	76	190, 903	39	308, 702	115	499, 605
July 1, 1906.....	33	175, 472	78	159, 299	111	334, 771	29	237, 814	140	572, 585
July 1, 1907.....	50	253, 949	84	149, 524	134	403, 473	45	151, 993	179	555, 466
July 1, 1908.....	13	41, 395	13	14, 775	13	14, 775	82	136, 091	95	150, 866
July 1, 1909.....	36	59, 692	52	127, 453	65	168, 848	52	164, 184	117	333, 032
July 1, 1910.....	53	71, 769	26	28, 626	79	100, 395	45	184, 096	144	329, 863
July 1, 1911.....	51	78, 353	80	192, 990	131	271, 313	130	119, 449	209	219, 844
July 1, 1912.....	63	40, 849	71	169, 580	134	210, 429	85	234, 923	216	506, 236
July 1, 1913.....	17	39, 337	24	104, 631	41	143, 968	123	230, 673	257	441, 102
July 1, 1914.....	14	15, 951	62	294, 188	76	310, 089	58	142, 910	99	286, 878
July 1, 1915.....	175	228, 345	210	997, 439	385	1, 225, 784	69	190, 780	145	500, 879
July 1, 1916.....	117	293, 161	322	1, 608, 361	499	1, 896, 522	60	79, 802	445	1, 305, 586

* Displacement.

Up to September 16, 1917, the contracts of the United States Shipping Board called for the construction of 225 steel ships of 1,790,800 tons dead weight, 342 wooden ships of 1,215,400 tons dead weight, and 58 composite ships of 207,000 tons dead weight; in all, 625 ships of 3,213,200 tons dead weight, equivalent, as practically all were cargo boats, to approximately 2,070,000 gross tons. These contracts have been modified, extensive new contracts have been made or are contemplated, and the execution of these contracts will absorb the activities of our shipyards, except for naval work, during the current fiscal year, as the private contracts made before July 1, 1917, yet to be performed, fast approach completion. The reports of the Shipping Board will cover fully its work.

LOSSES OF SHIPPING.

During the year, 73 American merchant vessels of 180,502 gross tons were destroyed by German submarines and mines. Details of war losses are printed in Appendix L. The total losses of American shipping during the year from enemy attacks and ordinary marine casualties were 484 vessels of 360,999 gross tons. Losses for former years are stated in Table 25.

Following is the British Admiralty statement of the shipping losses of civilized nations from enemy attacks and from marine casualties from July 1, 1917:

BRITISH, ALLIED, AND NEUTRAL TONNAGE LOSSES.

Period.	British.	Allied and neutral.	Total.
1917.			
July.....	Gross tons. 383,430	Gross tons. 192,519	Gross tons. 575,949
August.....	300,296	189,067	489,363
September.....	209,212	159,949	369,161
Total, 3 months.....	992,938	541,535	1,494,473
October.....	289,973	197,364	487,337
November.....	196,560	136,883	333,443
December.....	296,356	165,707	462,063
Total, 6 months.....	1,735,827	1,031,489	2,767,316
1918.			
January.....	218,528	136,187	354,715
February.....	264,303	132,324	396,627
March.....	224,666	176,797	401,463
Total, 3 months.....	697,497	445,318	1,142,815
April.....	228,067	85,348	313,415
May.....	231,780	132,708	364,488
June.....	165,514	115,980	281,494
Total, 6 months.....	1,322,858	779,349	2,102,207
Total, 12 months.....	3,058,685	1,810,838	4,869,523
July.....	182,524	141,248	323,772
August.....	176,401	151,275	327,676
September.....	161,593	86,007	247,600
Total.....	510,518	380,530	891,048

NETHERLANDS SHIPS.

The act of June 15, 1917, conferred upon the President power to take over the possession of any vessel within the jurisdiction of the United States for use or operation by the United States under the law and practice of nations which accords to a belligerent power the right in times of military exigency and for purposes essential to the prosecution of war to take over and utilize neutral vessels lying within its jurisdiction. The President, on March 20, 1918, proclaimed that the imperative military needs of the United States required the immediate utilization of vessels of Netherlands registry at the time within the territorial waters of the United States. The proclamation empowered the Secretary of the Navy to take over on behalf of the United States and to employ all such Netherlands vessels as may be necessary for essential purposes connected with the prosecution of the war, the United States Shipping Board to make to the owners full compensation in accordance with the principles of international law. The proclamation provided that these ships were to be manned, equipped, and operated by the Navy Department and the Shipping Board.

Under this proclamation, 87 ships of Netherlands registry of 354,479 gross tons in ports within American jurisdiction were requisitioned. Of these, 58, of 172,345 gross tons, were allotted to the

United States Shipping Board and the remainder to the Navy. A form of certificate of requisition based on the form of the usual certificate of registry, but reciting possession by the United States, represented by the United States Shipping Board instead of owner-ship, was issued to such ships allotted to the Shipping Board. Those allotted to the Navy have operated under the customary naval commission. These Netherlands ships are not a part of the American mercantile marine, and of course are not included in any of the statistics of this report. A list of them with essential facts about each is printed in Appendix N for reference and also in the List of Merchant Vessels.

NAVIGATION RECEIPTS.

The receipts for the past five fiscal years from the three main sources of revenue from navigation are shown in the following table:

Source.	1914	1915	1916	1917	1918
Tonnage duties.....	\$1,310,759.03	\$1,315,425.30	\$1,454,565.83	\$1,393,743.16	\$1,171,418.36
Navigation fees.....	152,694.19	142,446.37	158,518.08	159,808.03	146,508.02
Navigation fines.....	40,741.38	41,518.24	52,381.75	49,962.37	32,097.68
Yacht tax.....	446,870.60	37,976.30	19,849.71	.....	1,468.60
Total.....	1,951,065.10	1,537,366.21	1,655,315.37	1,603,513.56	1,351,492.66

TONNAGE DUTIES.

The receipts from tonnage duties during the year ended June 30, 1918, were \$1,171,418.36, including \$4,633.14 collected for the Philippine Islands fund and \$3,362.50 alien and penal tonnage duties. The receipts were \$222,324.80 less than during the fiscal year ended June 30, 1917. The decrease is due mainly to the extent to which troop ships and ships carrying supplies and munitions of war to our expeditionary forces abroad and those of our allies have given up their commercial character and have become instruments for the prosecution of the war. While the decrease is general, three-fourths of it occurred at four of the principal ports for the embarkation of troops and supplies and nearly half is due to the use of British merchant ships to transport our troops and munitions. Details of receipts of tonnage duties are stated in Appendix D.

SHIPPING COMMISSIONERS.

Summaries of the routine work of shipping commissioners for the past fiscal year are printed in Appendix A. Nearly all those employed in this service are over military age, and there have been few changes in the personnel. Inquiries as to the whereabouts of seamen facing the perils of war have increased in number, thereby increasing the clerical work. The scrutiny of crews is more thorough than in ordinary times.

MEN SHIPPED AND DISCHARGED.

During the year 457,248 officers and men have been shipped and discharged, compared with 506,941 during the previous year, in spite of the increase of our tonnage on transatlantic voyages. The decrease is due mainly to the increasing use of officers and enlisted men of the

Navy on ships engaged in transporting troops, munitions, and supplies to our expeditionary forces in Europe, and for the same reason it is possible that our increasing tonnage during the current year will not involve a large increase in the number of men shipped and discharged by the shipping commissioners.

The following statement shows the aggregate route work and salaries of commissioners and deputies for the past decade:

Year.	Seamen shipped, reshipped, and discharged.	Salaries.	Average cost per man.	Year.	Seamen shipped, reshipped, and discharged.	Salaries.	Average cost per man.
1909.....	341,980	\$62,944.79	\$0.18	1914.....	378,772	\$63,475.30	\$0.17
1910.....	356,448	65,539.19	.18	1915.....	414,744	63,755.47	.15
1911.....	367,023	67,155.90	.18	1916.....	487,524	62,037.45	.13
1912.....	374,783	62,373.53	.17	1917.....	506,941	66,211.83	.13
1913.....	379,188	62,374.13	.16	1918.....	457,248	72,075.48	.16

DESERTION OF SEAMEN.

Little permanent value is to be attached to the following return showing the number of men who have failed to join American ships in American ports after signing contracts before shipping commissioners, because conditions are altogether abnormal in nearly every respect.

Year.	Shipped and re-shipped.	Failed to join.	Per cent.	Year.	Shipped and re-shipped.	Failed to join.	Per cent.
1909.....	181,032	2,114	1.17	1914.....	199,584	2,771	1.39
1910.....	185,721	2,690	1.45	1915.....	218,541	3,339	1.53
1911.....	192,191	3,082	1.60	1916.....	252,681	4,512	1.71
1912.....	198,225	3,849	1.94	1917.....	257,327	5,006	1.95
1913.....	198,024	3,906	1.97	1918.....	232,340	4,446	1.91

ALLOTMENT NOTES.

The following table shows the number of allotment notes issued under section 24 of the seamen's act of December 21, 1898, and since November 4, 1915, under the seamen's act to seamen on vessels of the United States:

Year.	Creditors.		Relatives.	Total.	Year.	Creditors.		Relatives.	Total.
	Square-rigged.	All other vessels.				Square-rigged.	All other vessels.		
1905.....	1,595	919	304	2,818	1912.....	555	296	62	913
1906.....	1,492	421	309	2,222	1913.....	419	135	64	668
1907.....	1,323	490	239	2,052	1914.....	257	279	166	702
1908.....	967	393	133	1,498	1915.....	400	595	682	1,677
1909.....	660	114	84	858	1916.....	100	303	1,174	1,577
1910.....	631	145	79	905	1917.....			1,650	1,650
1911.....	505	241	67	803	1918.....			3,013	3,013

WAGES OF SEAMEN.

The customary tables showing the rates of monthly wages paid on merchant vessels of the United States during the past year for various ratings at principal seaports of the United States as reported

by shipping commissioners from articles of agreement are published in Appendix B. On May 18, 1918, the Shipping Board issued a scale of wages, representing an agreement with principal owners, and this is reprinted for future reference in Appendix B.

NATIONALITY OF CREWS.

The following table shows the nationality of officers and crews of American merchant vessels shipped before United States shipping commissioners during the past fiscal year compared with recent years. The numbers and percentage of American citizens are smaller, because many, of course, have enlisted in the Navy. Under permits from the Department of Justice a few Germans and Austrians were allowed to ship. The term Austrian is in many cases a misnomer in view of the recognition of the independence of races until recently under Austro-Hungarian domination.

Nationality	1911	1912	1913	1914	1915	1916	1917	1918
Americans (born).....	59,802	58,109	63,040	63,247	65,196	76,956	81,899	72,613
Americans (naturalized).....	31,810	35,562	32,780	31,417	29,965	31,877	26,826	24,868
British.....	23,674	21,033	24,031	24,745	20,395	20,523	28,947	26,967
Chinese.....	68	55	65	64	471	68	42	206
Japanese.....	380	190	193	98	200	245	368	663
Filipinos.....	126	184	258	472	482	528	650	9,617
Germans.....	7,673	7,185	9,185	9,497	9,466	12,415	10,254	10,096
Norwegians.....	9,889	9,394	8,679	8,194	9,891	11,383	9,819	5,467
Swedes.....	6,615	7,565	6,995	6,321	7,878	9,208	9,505	31,643
Danes.....	2,590	2,744	2,510	2,260	4,084	4,608	4,896	3,491
Russians.....	3,956	4,403	4,463	4,526	5,930	7,949	8,150	4,869
Austrians.....	1,838	2,240	2,980	3,363	3,536	3,474	1,894	9,127
French.....	610	614	615	617	716	892	783	206
Spanish.....	26,059	26,747	20,511	25,022	25,252	33,139	34,006	972
Italians.....	4,021	3,877	4,813	4,368	4,843	4,150	4,079	1,091
Portuguese.....	4,197	3,924	4,384	3,621	5,034	4,733	5,702	427
Others.....	8,766	11,762	12,434	11,442	16,196	21,533	25,322	.....
Unknown.....	117	3,037	68	10	6	.....	2	30,019
Total.....	192,191	198,225	198,024	199,584	218,541	252,681	253,141	232,340
Per cent Americans.....	47.7	47.3	48.4	47.4	43.5	43.2	42.9	41.9

RADIO COMMUNICATION.

Upon the declaration of war 18 of the 25 men in the radio inspection force volunteered and were commissioned as officers in the Army and Navy. They have served with credit in responsible positions which called for their technical knowledge with our expeditionary forces in France, at sea, and wherever assigned to duty. During the year ended June 30, 1918, the work was carried on by substitutes and these have been leaving to enter the military and naval service. The demand for radio apparatus for the Navy and for new merchant ships has been very heavy, and to economize resources it was arranged that the Navy Department should allot such apparatus to its own ships and to merchant ships and later that the Navy should keep in repair apparatus for Shipping Board ships as well as for the Navy. This arrangement and the obvious fact that enough apparatus to comply in all respects with the laws could not be produced led to a change in the inspection system in November, 1917. Inspection of merchant ships furnished with apparatus on naval allotment was discontinued except in so far as it is continued by the Navy, which makes the repairs. As practically all British, French, Italian, Japanese, and other allied ships and their radio

apparatus and operators are under control of the military branches of their respective governments, the inspection in American ports was accordingly modified. The number of inspections of ships, accordingly, was 4,341 out of 9,706 clearances compared with 6,103 out of 12,139 clearances during the previous year.

The number of clearances of ships required to carry wireless and of the inspection of such ships is shown by the following statement:

CLEARANCES AND INSPECTIONS OF VESSELS SUBJECT TO THE SHIP ACT OF JUNE 24, 1910, AS AMENDED JULY 23, 1912, DURING THE FISCAL YEAR 1913.

(District headquarters are indicated by small capitals.)

District.	Port.	Clearances.	Inspections.	District.	Port.	Clearances.	Inspections.
1st	Boston, Mass.	742	674	6th	SAN FRANCISCO, CAL.	1,031	659
	Portland, Me.	96			Eureka, Cal.	17	
	Providence, R. I.	90			Honolulu, Hawaii	213	
2d	New York, N. Y.	2,425	1,468		Los Angeles, Cal.	253	
	Perth Amboy and Newark, N. J.	113			San Diego, Cal.	116	
3d	Baltimore, Md.	167	103	7th	SEATTLE, WASH.	378	298
	Newport News, Va.	175	86		Astoria, Oreg.	62	
	Norfolk, Va.	757	486		Bellingham, Wash.	11	
	Philadelphia, Pa.	348	44		Cordova, Alaska	5	
4th	Savannah, Ga.	342			Juneau, Alaska	2	
	Brunswick, Ga.	11			Ketchikan, Alaska	273	
	Charleston, S. C.	150			Portland, Oreg.	99	
	Key West, Fla.	190			Sulzer, Alaska	5	
	Pensacola, Fla.	12			Tacoma, Wash.	43	
	San Juan, P. R.	252		8th	DETROIT, MICH.	216	92
	Tampa, Fla.	108			Buffalo, N. Y.	199	7
5th	NEW ORLEANS, LA.	506	394	9th	CHICAGO, ILL.	72	43
	Galveston, Tex.	158	7		Duluth, Minn.	53	
	Mobile, Ala.	11			Total, 1913.	9,706	4,341
	Pascagoula, Miss.	3			Total, 1917.	12,139	6,103
	Port Arthur, Tex.	72					

The total number of ship inspections for the fiscal years 1913-1918, inclusive, is as follows: 1913, 3,201; 1914, 6,486; 1915, 6,152; 1916, 7,236; 1917, 7,137; 1918, 5,775; total, 35,987.

During the year 392 ship-station licenses were issued compared with 484 during the previous year, although the number of such stations has increased rapidly, as shown, by about 1,500 radio letters issued to ships and only 839 outstanding ship licenses. This work is in arrears under the present arrangement and can not be brought to date until the information about apparatus necessary to conform to the International Convention and the act of Congress has been given and the inspections made.

During the year 1,942 licenses were issued to commercial operators of various grades. The number and grade of licenses issued or renewed during the past six years were as follows:

Grade.	1913	1914	1915	1916	1917	1918	Total.
Commercial extra first.			18	18	8	13	57
Commercial first and second.	1,932	339	1,635	1,260	1,674	1,603	8,443
Experiment and instruction.	8	10	27	30	10	(a)	85
Cargo.	1	6	112	173	113	107	533
Amateur first and second.	1,841	1,172	3,067	4,199	3,302	(a)	13,581
Commercial emergency first and second.					217	219	436
Total.	3,782	1,547	4,859	5,680	5,324	1,942	23,194

(a) Discontinued for the period of the war.

The total number of licensed American commercial operators of various grades at the end of the year was approximately 3,200.

The prosecution of the war demands a large increase in the number of radio operators, and in addition to their statutory duties the radio inspectors have aided in training young men for the work. At Boston, with the cooperation of the Massachusetts Committee on Public Safety, the collector of customs, and others, the radio inspector has established a school from which during the year 200 students were graduated into the Army or Navy. At Detroit, working with the Young Men's Christian Association, the inspector established a similar school, from which 131 were sent to the Army or Navy and 95 were graduated as commercial operators. The inspectors at New Orleans and Norfolk conduct similar schools, and at New York and Seattle the inspectors devote their time outside of official work to instruction in radio telegraphy in the local schools.

ENFORCEMENT OF NAVIGATION LAWS.

The field force employed during the year in the enforcement of the navigation laws consists of 56 navigation inspectors, 14 radio inspectors, the marine divisions of the customhouses, and the crews of the motor vessels *Kilkenny* and *Tarragon*.

The following table shows the work by districts and laws violated, followed by comparison of the work in previous years:

VIOLATIONS OF NAVIGATION LAWS REPORTED BY THE VARIOUS COLLECTORS OF CUSTOMS, SHOWING THE LAWS VIOLATED, FISCAL YEAR ENDED JUNE 30, 1918, COMPARED WITH PREVIOUS YEARS.

Headquarters port.	Total.	Steamboat laws (R. S., 4399-4500).	Motor boat law, "Rules of road."	Surrendered license (R. S., 4325-4326).	Bills of health (Feb. 15, 1893), ^a	Seamen's act (Mar. 4, 1915).	Anchorage and St. Marys River rules. Passenger act (Aug. 2, 1882).	Enrollment and li- cense (R. S., 4336).	Entry and clearance (R. S., 4197, 2774).	Name on vessel (R. S., 4178).	Change of master (R. S., 4335).	Unlading.	Radio communica- tion laws.	Miscellaneous.
Baltimore.....	265	7	203	42	41	14	8	2	8	12	1	5	1	4
Boston.....	194	42	69	41	23	17			1		48	3		1
Bridgeport.....	32	4		23	1					2		48		
Buffalo.....	111	43		4	22								1	1
Charleston.....	28		4	22	4	1						23		
Chicago.....	144	12	104	4								48		
Cleveland.....	177	77	23	20					7					2
Denver.....														
Des Moines.....	56		52	1				1				2		
Detroit.....	146	14	92	21		2		2				13		2
Duluth.....	132	62	42	2		14		1	2	3		5		1
Eagle Pass.....	1													
El Paso.....														
Galveston.....	54	44	2	7								1		
Great Falls.....														
Honolulu.....	11								2		1	8		
Indianapolis.....	85		82							3				
Juneau.....	44		4	34				1	3			2		
Laredo.....														
Los Angeles.....	109		84	24								1		
Louisville.....	50	7	18	21						4				
Memphis.....	18	4	8	5							1			
Milwaukee.....	18	1	12			1						4		
Mobile.....	52	4	8	27		3		1	1					8
New Orleans.....	221	84	43	78					4			1	7	1

^aBills of health cases transferred to Treasury Department, July 24, 1911.

VIOLATIONS OF NAVIGATION LAWS REPORTED BY THE VARIOUS COLLECTORS OF CUSTOMS, SHOWING THE LAWS VIOLATED, FISCAL YEAR ENDED JUNE 30, 1918, COMPARED WITH PREVIOUS YEARS—Continued.

Headquarters port.	Total.	Steamboat laws (R. S., 4399-4600).	Motor boat law, "Rules of road."	Surrendered license (R. S., 4325-4326).	Bills of health (Feb. 15, 1893).	Seamen's act (Mar. 4, 1915).	Anchorage and St. Marys River rules. Passenger act (Aug. 2, 1892).	Enrollment and li- cense (R. S., 4339).	Entry and clearance (R. S., 4197, 2774).	Name on vessel (R. S., 4178).	Change of master (R. S., 4336).	Unbiding.	Radio communica- tion laws.	Miscellaneous
New York.....	583	88	305	122	1	3	1	18	36	3	1	22	3	
Nogales.....	22													
Norfolk.....	181	87	92	29	2		1		16		1	46		
Ogdensburg.....	201	1	129	24										
Omaha.....	3			3										
Pembina.....	166	33	81	44	6			1				1		
Philadelphia.....	6	3	1	2										
Pittsburgh.....	117	64	11	18	2	1			2		3	11	5	
Port Arthur.....	51	10	17	23	1								1	
Portland, Me.....	239	3	221	9	2		1		1	2				
Portland, Oreg.....	68	7	47	11	2					1				
Providence.....	102	2	100											
Rochester.....	29	3	21		1				4					
St. Albans.....	173	2	155	16										
St. Louis.....														
St. Paul.....														
Salt Lake City.....														
San Antonio.....	2												2	
San Francisco.....	151	10	36	35	3	7	6	6	18	11	4	1	14	
San Juan.....	14	2	2	5						3		2		
Savannah.....	41	10	13	7	4		1			5			1	
Seattle.....	338	5	105	136	50	11	1	8	16	1	3	1		
Tampa.....	295	21	139	62	34	2	1	1	10		19		6	
Wilmington, N. C.....	19	4	11	4										
Total—														
1918 (40 ports).....	4,749	710	2,337	922	160	32	20	62	127	27	250	20	82	
1917 (48 ports).....	7,569	1,020	4,660	770	286	29	42	43	400	41	74	22	182	
1916 (48 ports).....	7,825	812	5,126	943	271	1	59	28	331	35	67	13	90	
1915 (48 ports).....	6,868	671	4,462	982	11	10	104	41	348	67	93	37	42	
1914 (40 ports).....	6,720	768	4,838	631	8	25	41	26	153	59	90	36	45	
1913 (107 ports).....	3,506	333	2,783	23	23	8	24	10	83	25	1	40	152	
1912 (105 ports).....	3,634	165	3,119	96	3	12	38	39	81	12			52	
1911 (92 ports).....	2,268	182	1,811	28	41	17	45	10	16	43	30		50	
1910 (74 ports).....	1,070	252	488	17	52	13	61	13	16	68	12	2	76	
1909 (64 ports).....	1,134	151	710	33	60	3	21	14	7	59		4	63	
1908 (73 ports).....	852	245	385	12	42	6	21	23	18	30	7	2	61	
1907 (66 ports).....	684	209	92	88	36	18	62	9	23	52	27	5	63	
1906 (77 ports).....	670	194	130	114	41	13	27	10	6	49	5	9	72	
1905 (63 ports).....	524	142	53	99	42	13	21	26	7	20	11	28	62	
1904 (66 ports).....	706	184	93	101	48	49	16	29	12	24	19	(4)	131	

* The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order dated Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

* Reports are now made by subports through the principal port of the district.

* Included under "Miscellaneous" in 1904 report.

From the above table a material decrease in the reports of violations of the navigation laws will be noted. This is due in most part to improvement in the equipment and navigation of vessels and to a decreased use of motor boats, owing to the increased cost of gasoline and the numerous restrictions placed upon the use of such vessels.

The following table shows the work done by the various branches of the services engaged in the enforcement of the navigation laws:

NUMBER OF VIOLATIONS OF THE NAVIGATION LAWS ON WHICH PENALTIES WERE
IMPOSED AND SOURCES OF THE REPORTS FOR FISCAL YEAR 1918.

Headquarters port.	Total.	Coast Guard.	Tarra- gon.	Kill- kenny.	Local inspec- tors.	Radio inspec- tors.	Cus- toms.	Navi- gation inspec- tors.	Cases re- ported under allot- ments.
Baltimore.....	266		33	33	4		43	148	148
Boston.....	186	1			31	2	139	15	15
Bridgeport.....	31				3		28		
Buffalo.....	105		1		47		57		
Charleston.....	26			4			22		
Chicago.....	142	41			14		87		
Cleveland.....	169				75		78	16	16
Des Moines.....	55						55		52
Detroit.....	145	86			13		46		
Duluth.....	132	4					103	25	25
Eagle Pass.....	1						1		
Galveston.....	48						48		
Honolulu.....	7						7		
Indianapolis.....	81	1					28	52	52
Juneau.....	43						43		
Los Angeles.....	116	5			7		111		84
Louisville.....	55				7		25	23	23
Memphis.....	22				3		15	4	4
Milwaukee.....	15	9					7		
Mobile.....	51	3			1		47		
New Orleans.....	209	1	18		9		180		
New York.....	697		421	3	81	1	155	36	36
Nogales.....	24						24		
Norfolk.....	208			21	40		53	94	94
Ogdensburg.....	195		128		1		66		
Pembina.....	3						3		
Philadelphia.....	196				8		119	69	69
Pittsburgh.....	6				3		3		
Port Arthur.....	102	4			10		88		
Portland, Me.....	23				9		18	1	1
Portland, Oreg.....	251						251		
Providence.....	79				6		21	52	52
Rochester.....	102		81				21		
St. Albans.....	27		21		1		5		5
St. Louis.....	207				1		200	6	6
San Antonio.....	2						2		
San Francisco.....	143	74			1	1	67		
San Juan.....	14						14		
Savannah.....	39			6	11		22		
Seattle.....	375	10			1	1	208	155	155
Tampa.....	274	2	106	8	22	1	135		
Wilmington, N. C.....	15			4	2		9		
Total—									
1918 (49 ports).....	4,893	241	809	84	404	5	2,654	696	726
1917 (48 ports).....	7,565	1,255	1,234	864	712	13	2,833	654	1,159
1916 (48 ports).....	7,895	1,333	987	984	590	36	2,876	1,089	1,178
1915 (48 ports).....	6,860	1,380	1,425		361	34	2,661	999	1,401
1914 (49 ports).....	9,720	922	1,762		734	27	3,275		1,825

*The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order dated Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

The foregoing statement of the work done by the various inspection services is compiled from reports made by collectors of customs on Catalogue 1078 and is approximately correct.

The motor vessel *Kilkenny* was acquired at the beginning of the fiscal year, but was not ready for service until after the close of the summer season. Later in the year she was in the shipyard, having her wireless equipment installed. For these reasons returns from her work will begin to appear in the present fiscal year.

COMPARATIVE STATEMENT OF CASES OF VIOLATIONS OF THE NAVIGATION AND STEAMBOAT-INSPECTION LAWS REPORTED BY OFFICERS OF CUSTOMS, 1904-1918.

Port.	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	Total.
Baltimore.....	65	30	14	34	21	43	49	114	129	204	219	396	312	461	265	2,446
Boston.....	27	33	40	15	8	18	24	132	327	67	949	440	412	427	194	3,132
Bridgeport.....	8	7	12	9	9	4	13	206	423	30	134	118	54	89	32	1,148
Buffalo.....	1	3	3	5	10	8	32	9	75	64	3	42	144	87	111	597
Charleston.....	2	5	5	21	3	2	4	1	4	13	154	91	39	50	26	417
Chicago.....	8	7	8	7	21	5	70	139	55	35	105	178	399	253	144	1,463
Cleveland.....	14	14	40	20	27	10	32	114	66	76	90	104	218	161	177	1,143
Denver.....	1	1	2	3	5	4	1	1	1	1	1	1	1	1	1	1
Des Moines.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Detroit.....	33	23	41	48	28	96	161	69	251	281	293	441	163	146	2	2,116
Duluth.....	34	16	15	16	15	14	46	9	13	15	17	62	79	138	132	621
Eagle Pass.....	7	5	8	15	5	9	1	1	1	1	1	1	1	1	1	1
Galveston.....	7	5	8	15	5	9	1	1	1	1	1	1	1	1	1	1
Great Falls.....	6	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Honolulu.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Indianapolis.....	18	21	10	22	9	8	17	113	67	27	41	43	33	40	44	513
Jameau.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Laredo.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Los Angeles.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Louisville.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Memphis.....	3	3	7	4	4	3	8	10	12	9	10	62	94	84	18	316
Milwaukee.....	2	6	9	4	14	19	13	16	22	16	16	8	133	62	18	378
Mobile.....	21	35	32	23	6	9	41	36	40	30	157	107	106	109	52	804
New Orleans.....	11	15	38	21	21	16	24	51	71	73	218	173	177	315	221	1,445
New York.....	164	132	160	124	250	633	174	222	352	330	1,013	622	1,256	1,292	563	7,392
Nogales.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Norfolk.....	43	13	21	16	170	66	43	214	121	490	235	335	531	430	181	2,908
Ogdensburg.....	5	4	2	4	4	6	6	13	25	20	57	40	92	74	201	553
Pembina.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Philadelphia.....	25	12	26	16	10	8	17	25	28	164	378	867	483	406	166	2,631
Pittsburgh.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Portland, Me.....	7	9	5	7	14	13	26	86	157	51	78	566	241	145	51	1,456
Portland, Oreg.....	7	7	11	5	2	3	6	7	125	331	354	273	229	130	239	1,739
Providence.....	1	2	14	9	9	13	7	79	70	20	130	21	125	94	68	662
Rochester.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
St. Albans.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
St. Louis.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
St. Paul.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
San Antonio.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
San Francisco.....	6	20	11	73	25	20	70	103	64	107	260	446	276	196	151	1,826
San Juan.....	11	4	4	3	13	3	9	9	25	18	28	28	11	12	14	192
Savannah.....	5	1	7	1	6	2	1	2	7	6	98	78	82	48	41	395
Seattle.....	138	54	72	87	33	29	19	74	108	59	38	306	400	318	338	2,425
Tampa.....	27	33	46	54	29	27	80	135	682	364	669	314	570	547	296	3,572
Wilmington, N. C.....	4	3	5	1	8	11	5	23	20	373	104	206	137	262	19	1,151
Total (47 ports).....	706	524	670	684	852	1,134	1,070	2,268	3,634	3,506	6,720	6,863	7,825	7,569	4,749	43,773

* The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by executive order dated Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

PREVENTION OF OVERCROWDING OF PASSENGER VESSELS.

During the fiscal year this work continued with little change from the previous fiscal year, so far as our navigation inspectors are concerned, the number of counts of passengers increasing from 6,622 in 1917 to 8,847 in 1918, but the number of passengers counted decreased from 2,949,299 in 1917 to 2,931,570 in 1918. The total number of passengers counted by all the services during the year decreased from 6,796,441 in 1917 to 4,916,772 in 1918.

The following table shows by ports 385 occasions on which vessels reached their passenger capacity and were prevented by the inspectors from taking on more passengers. The safety of 268,020 passengers was involved. It has been the consistent practice of the Bureau

to prevent violations of law rather than to permit the overcrowding of these vessels and then impose penalties on the owners.

SHUT-OFFS, BY MONTHS, DURING THE FISCAL YEAR 1918.

Ports.	July.		August.		September.		May.		June.		Total	
	Counts.	Passengers.	Counts.	Passengers.	Counts.	Passengers.	Counts.	Passengers.	Counts.	Passengers.	Counts.	Passengers.
Baltimore.....	3	1,950	9	11,080	2	2,695	1	1,547	1	1,200	16	18,472
Boston.....	17	29,090			6	7,155					23	36,245
Buffalo.....	1	3,500	1	2,500					2	1,300	4	7,300
Charleston.....	1	300	1	500	1	585	3	1,052	1	151	7	2,588
Chicago.....	127	23,131	37	36,816	1	127	9	1,791	66	12,376	240	74,241
Cleveland.....	12	15,564	17	27,017					3	7,000	33	49,581
Detroit.....	11	28,542	5	15,162	1	3,000			1	3,000	18	49,704
Duluth.....	2	1,836	2	1,104							4	2,940
Galveston.....	1	2									1	2
Louisville.....	1	800							1	1,200	2	2,000
Memphis.....							1	1,000	4	4,000	5	5,000
Mobile.....	6	2,573	2	938					2	1,136	10	4,647
New York.....	1	500	2	1,000							3	1,500
Norfolk.....			1	400			1	1,000	2	400	4	1,800
Ogdensburg.....	1	300	3	1,400							4	1,700
Philadelphia.....	2	2,100									2	2,100
Portland, Me.....			1	420							1	420
Portland, Oreg.....									1	450	1	450
Providence.....	1	400	1	800	2	2,569					4	3,769
Rochester.....	2	2,876			1	685					3	3,561
Total.....	188	112,664	83	99,937	14	16,816	15	6,390	85	32,213	385	268,020

The following table shows the work in detail by both the navigation and customs officers:

NUMBER OF COUNTS AND THE NUMBER OF PASSENGERS INVOLVED IN PREVENTING OVERCROWDING OF PASSENGER VESSELS DURING FISCAL YEAR 1918.

Port.	Navigation.		Customs.		Total.	
	Counts.	Passengers.	Counts.	Passengers.	Counts.	Passengers.
Baltimore.....	1,675	784,284			1,675	784,284
Boston.....			931	669,616	931	669,616
Buffalo.....			3,216	663,247	3,216	663,247
Charleston, S. C.....			10	3,858	10	3,858
Chicago.....	2,133	389,263	82	43,216	2,215	432,479
Cleveland.....	2,478	604,767	266	212,143	2,744	816,910
Des Moines.....			1	846	1	846
Detroit.....	624	698,937	73	118,025	697	816,962
Dubuque.....			2	611	2	611
Duluth.....	163	40,898	3	891	166	41,289
Galveston.....			83	2,688	83	2,688
Indianapolis.....	27	11,188	13	4,529	40	15,717
Louisville.....	210	74,774			210	74,774
Memphis.....	177	81,986			177	81,986
Milwaukee.....				5,088	11	5,088
Mobile.....			88	25,991	88	25,991
New York.....			25	14,150	25	14,150
Norfolk.....	139	29,407	48	20,618	187	44,025
Ogdensburg.....			15	7,141	15	7,141
Philadelphia.....	3	1,158	191	14,411	194	145,169
Port Arthur.....			23	51	23	51
Portland, Me.....	490	60,678	7	717	497	61,395
Portland, Oreg.....			10	3,250	10	3,250
Providence.....	323	160,730	6	2,062	329	162,792
Rochester.....			18	11,398	18	11,398
St. Albans.....			7	1,215	7	1,215
Total.....	8,447	2,931,570	5,129	1,985,202	13,574	4,916,772
Total for sea, coast and lake.....	6,822	2,649,292	4,944	3,847,142	11,766	6,496,434

NUMBERING UNDOCUMENTED VESSELS.

On June 7, 1918, the act requiring the numbering of undocumented vessels became law effective six months after its passage. Although this law does not go into effect until December 7, 1918, a large proportion of the owners of such vessels have availed themselves of the opportunity of having their boats numbered. This law intended originally to assist in the enforcement of the navigation laws through the identification of the owners of these small vessels has helped also in the enforcement of regulations issued under the espionage act and in the collection of internal revenue taxes on the use of these vessels. The field force of the Bureau is actively cooperating with the Bureau of Internal Revenue in the collection of such taxes, and our force, being trained in the work of inspection, familiar with the location of these vessels, especially outside of the principal ports, should render material assistance.

PASSENGER ACT OF 1882.

During the past fiscal year passenger ships on 442 voyages brought 67,988 steerage passengers to the United States, compared with 630 voyages carrying 147,493 passengers in the fiscal year 1917, 720 voyages carrying 154,057 passengers in 1916, 956 voyages carrying 211,057 passengers in 1915, and 1,797 voyages carrying 1,016,453 passengers in 1914.

ADMEASUREMENT AND LOAD LINE OF VESSELS.

With the unprecedented increase in shipbuilding the importance of this branch of the Bureau's work increases. A large proportion of this shipbuilding is for the ocean trade, subject to canal tolls, tonnage taxes, dockage, pilotage, dry-dock, and other charges. Accurate measurement of these vessels is essential. The adjuster of admeasurement has visited the various admeasurement centers and considerably improved this branch of our service, but we can only approach the accuracy and efficiency of leading maritime nations in this respect under the present unsatisfactory method of administering the laws relating to admeasurement. The admeasurement of a vessel is complicated and requires technical and practical knowledge. This work is done now by customs officers appointed in most instances because of qualifications for customs service and detailed to the measurement of vessels, as an incident to their customs work. Only eight of the principal ports have a force of admeasurers of vessels who are not employed on other work. The entire force is organized along customs lines rather than on the basis of shipbuilding industry, which results in inconveniences and in many cases additional expense.

The establishment of load lines under Government supervision is now a necessity for which Congress should soon provide, and the administrative treatment of that subject and of admeasurement may well be combined.

WAR SERVICE.

It is only a slight recognition of their worth and patriotism to make a permanent record in this report of the names of those who left this Bureau to enter the Army or the Navy of the United States, and it is the wish of all the remaining employees of the Bureau that such record be made.

Following is the list of the names of the employees of the Bureau in the Army or the Navy of the United States and the positions they held in the Bureau on the declaration of war or subsequently:

Name.	Position.	United States service.
Batcher, Ralph R.....	Assistant radio inspector.....	Navy.
Belt, Philip C.....	Navigation inspector.....	Army.
Blaney, Joseph L.....	do.....	Naval Reserve Corps.
Cadmus, Richard Y.....	Radio inspector.....	Lieutenant, Navy.
Corrison, Lawrence A.....	Clerk, Bureau.....	Army.
DeRosier, William N.....	do.....	Corporal, Army, O. T. C.
Devlin, Raymond A.....	do.....	Army.
Dillon, John F.....	Radio inspector.....	Major, A. E. F. in France.
Flaher, Frank S.....	Assistant radio inspector.....	Army.
Gawler, Henry C.....	Radio inspector.....	Lieutenant, Navy, European waters.
Greaves, V. Ford.....	Radio engineer.....	Lieutenant, Navy.
Hayes, Harold D.....	Assistant radio inspector.....	Lieutenant.
Henry, Newport F.....	Messenger, Bureau.....	Army, O. T. C.*
Kolster, Charles C.....	Radio inspector.....	Lieutenant, Navy.
Kros, Frank A.....	Clerk, Bureau.....	Army.*
Krumm, Louis R.....	Chief radio inspector.....	Lieut. Col., A. E. F. in France.
Lawson, George W.....	Clerk, Shipping Service.....	Naval Reserve Corps.
Lipking, Norman J.....	Clerk, Bureau.....	A. E. F. in France.
McCarthy, Bartholomew.....	Clerk, Radio Service.....	Do.
McGown, Dudley B.....	Assistant radio inspector.....	Naval Reserve Corps.
Martin, DeLoes K.....	Radio inspector.....	Electrician, Navy.
Mendelson, Albert.....	Clerk, Radio Service.....	Army.
Morse, Charles E.....	Clerk, Bureau.....	Corporal, Army.
Murray, Steven E.....	Clerk, Radio Service.....	Navy.
Naah, Merrit J.....	Navigation inspector.....	Army.
Pellock, Abram.....	Clerk, Bureau.....	Navy.
Priess, William H.....	Assistant radio inspector.....	Lieutenant, A. E. F. in France.
Redfern, Otto R.....	do.....	Ensign, Navy.
Sadenwater, Harry.....	do.....	Do.
Sanford, Jesse B.....	Clerk, Bureau.....	A. E. F. in France.
Schlang, Herman.....	Clerk, Radio Service.....	Electrician, Navy.
Smidl, Edward.....	Navigation inspector.....	A. E. F. in France.
Stone, Ellery W.....	Assistant radio inspector.....	Lieutenant, Navy.
Stroebe, John C., Jr.....	do.....	Electrician, Navy.
Swanson, John W.....	Radio inspector.....	Ensign, Navy.
Thomas, Alfred.....	Assistant radio inspector.....	Captain, Army.
Torrance, Thomas M.....	Messenger, Bureau.....	A. E. F. in France.
Van Nostrand, Walter, Jr.....	Clerk, Bureau.....	Lieutenant, A. E. F. in France.
Wolf, Benjamin E.....	Radio inspector.....	Lieutenant, Navy.

* Honorably discharged owing to physical condition.

The names of those about to be called to the colors are not included because the arm of the service in which they will serve is not yet determined.

Respectfully,

EUGENE TYLER CHAMBERLAIN,
Commissioner.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

97796°—COM 1918—52

NOTE.—The report of the Commissioner of Navigation, as separately published, contains also the following appendixes and statistical tables:

APPENDIXES.

- (A) Reports of shipping commissioners for year ended June 30, 1918—(1) Shipments, discharges, and expenditures; (2) Shipments and reshipments of seamen; (3) Number of men discharged; (4) Nationality of seamen; (5) Failures of seamen to join American vessels; (6) Men shipped to be discharged in foreign ports; (7) Allotments of wages; (8) Seamen shipped and discharged by collectors.
- (B) Wages of seamen—(1) Average monthly wages paid in the American merchant marine, year ended June 30, 1918; (2) Average monthly wages paid to able seamen on American vessels, 1895–1918; (3) Average monthly wages paid to first mates on American vessels, 1895–1918; (4) Average monthly wages paid to firemen and first engineers on American steam vessels, 1895–1918; (5) Wage scales established by the United States Shipping Board.
- (D) Tonnage tax—Law and collections—(1) Tonnage-tax collections, 1884–1918; (2) Tonnage tax collected, year ended June 30, 1918, by customs districts; (3) Tonnage tax collected, year ended June 30, 1918, by nationality of vessels; (4) Tonnage tax collected, year ended June 30, 1918, by countries from which the vessels entered.
- (E) Steel-ship building in the United States—(1) Construction of steel steam vessels in the United States, 1909–1918.
- (F) The world's tonnage, motive power, and materials of construction—(1) World's tonnage, based on official returns, 1850–1911 (from Return on Progress of British Shipping for 1912); (2) Number and net and gross tonnage of steam and sailing vessels as recorded by the Bureau Veritas for 1917–18; (3) Number and net and gross tonnage of steam and sailing vessels of over 100 tons, of the several countries of the world, as recorded in Lloyd's Register for 1916–17; (4) Motive power and chief materials of construction of the world's merchant marine, 1890–1916 (Lloyd's); (5) Total number and tonnage of steam vessels (over 100 tons) and sailing vessels (over 50 tons), 1890–1917 (Bureau Veritas); (6) Construction—Vessels built in the world (over 100 tons) according to Lloyd's (including vessels not recorded in Lloyd's) during 10 recent years; (7) The world's shipbuilding in 1915, excluding warships (Lloyd's summary); (8) Merchant vessels under construction June 30, 1916 (Lloyd's); (9) Number, tonnage, and nationality of vessels totally lost, condemned, etc., during the year 1914, as reported up to July 12, 1915; also the number and tonnage of steam and sailing vessels owned in each country.
- (G) Progress of British, German, and Japanese shipping.
- (I) Foreign-built yachts—Tax levied at the rate of \$7 per gross ton under authority of section 37 of the act of August 5, 1909, and collected during the fiscal year 1918.
- (J) Square-rigged American vessels.
- (L) Foreign-built vessels admitted to American registry during the two years ended June 30, 1918, classified in chronological order of issue of registry.
- (M) War losses—(1) American documented vessels destroyed by mines, submarines, etc., from the beginning of the war to June 30, 1918; (2) War losses since June 30, 1918; (3) Undocumented American vessels destroyed.
- (N) Dutch vessels requisitioned under authority of the proclamation of the President of the United States, March 20, 1918.
- (O) Miscellaneous—(1) Foreign carrying trade of the United States, 1821–1918; (2) Tonnage of American and foreign vessels entered and cleared in the foreign trade of the United States, fiscal years 1821–1918; (3) Water-borne imports and domestic exports of United States, by nationality of vessels, fiscal years 1914–1918; (4) Water-borne imports and exports of United States, by months fiscal years 1914–1918; (5) American merchant vessels sold to aliens during the past two years.

STATISTICAL TABLES.

- (1) Number and gross tonnage of documented vessels of the United States, by customs districts, June 30, 1918.
- (2) Number and gross tonnage of documented vessels of the United States, by States and Territories, June 30, 1918.
- (3) Number and gross tonnage of documented steam and gas vessels of the United States, by customs districts, June 30, 1918.
- (4) Number and gross tonnage of documented metal vessels of the United States, by customs districts, June 30, 1918.
- (5) Number and gross tonnage of documented steam and gas metal vessels of the United States, by customs districts, June 30, 1918.
- (6) Class, number, and gross tonnage of documented metal vessels of the United States, by customs districts, June 30, 1918.
- (7) Number and gross tonnage of each class of documented wooden and metal vessels of the United States, June 30, 1918.
- (8) Balance sheet of tonnage accounts, showing the increase and decrease of documented vessels, June 30, 1918.
- (9) Balance sheet of tonnage accounts, showing the increase and decrease in each class of vessels, June 30, 1918.
- (10) Documented sailing and steam tonnage constituting the total merchant marine of the United States, 1789-1918.
- (10a) Number and gross tonnage of canal boats and barges documented in the United States, in specified years, 1868-1918.
- (10b) Number and gross tonnage of sailing vessels, steam vessels, canal boats, and barges documented on the northern lakes, in specified years, 1868-1918.
- (11) Number and gross tonnage of sailing vessels, steam vessels, gas vessels, canal boats, and barges in the United States, by customs districts, June 30, 1918.
- (12) Number and gross tonnage of sailing vessels, steam vessels, gas vessels, canal boats, and barges in the United States, by States, June 30, 1918.
- (13) Sailing, steam, and gas vessels of the United States, according to size, June 30, 1918.
- (14) Number and gross tonnage of vessels of the United States engaged in the cod and mackerel fisheries, by customs districts, June 30, 1918.
- (15) Number and gross tonnage of vessels of the United States engaged in the whale fisheries, by ports, June 30, 1918.
- (16) Documented tonnage of the United States merchant marine employed in the foreign trade, the coasting trade, and the fisheries, 1789-1918.
- (17) Employment of the tonnage of the United States, June 30, 1918.
- (18) Class, number, and gross tonnage of vessels built in the United States and documented during year ended June 30, 1918, by customs districts.
- (19) Class, number, and gross tonnage of sailing vessels built in the United States and documented during the year ended June 30, 1918.
- (20) Class, number, and gross tonnage of steam and gas vessels built in the United States and documented during the year ended June 30, 1918.
- (21) Class, number, and gross tonnage of steel vessels built in the United States and documented during the year ended June 30, 1918.
- (22) Class, number, and gross tonnage of metal vessels built in the United States and documented, 1838-1918.
- (23) Class, number, and gross tonnage of vessels built in the United States and documented, 1797-1918.
- (24) Number and gross tonnage of vessels built in the United States and documented, by geographic divisions, 1857-1918.

- (25) Tonnage of vessels of the United States which have been built, admitted to registry by acts of Congress, etc., and those which have been lost, abandoned, sold to aliens, etc., 1813-1918.
- (26) Class, number, and gross tonnage of documented yachts of the United States, by ports, June 30, 1918.
- (27) Class, number, and gross tonnage of documented metal yachts of the United States, by ports, June 30, 1918.
- (28) Class, number, and gross tonnage of yachts built in the United States and documented during the year ended June 30, 1918, by customs districts.
- (29) Class, number, and gross tonnage of documented yachts lost, abandoned, sold to aliens, etc., year ended June 30, 1918.

[Tables 1-9, 11-15, and 17-21 are also printed as of June 30, 1917, having been omitted from the report of the Commissioner of Navigation for that year on account of the war. There is also printed in the Commissioner's report for 1918, as separately published, a statement as to steel steam vessels building or contracted for on July 1, 1917.]

REPORT
OF THE
CHIEF OF THE APPOINTMENT DIVISION

821

REPORT OF THE CHIEF OF APPOINTMENT DIVISION.

DEPARTMENT OF COMMERCE,
APPOINTMENT DIVISION,
Washington, September 3, 1918.

SIR: There is submitted herewith my annual report as Chief of the Appointment Division for the fiscal year ended June 30, 1918.

STATISTICS RELATING TO THE PERSONNEL.

The accompanying table shows, by bureaus, the number of permanent positions in the Department on July 1, 1918, and the increase or decrease in each bureau as compared with July 1, 1917. The figures do not include temporary appointments, nor do they include the following appointments or employments not made by the head of the Department: Persons engaged in rodding, chaining, recording, heliotroping, etc., in field parties of the Coast and Geodetic Survey; temporary employments in field operations of the Bureau of Fisheries; mechanics, skilled tradesmen, and laborers, employed under authority of Schedule A, Subdivision I, section 12, of the civil-service rules in the Lighthouse Service. Enlisted men on vessels of the Coast Survey in the Philippine Islands and officers and men of the Navy Department employed on vessels of the Bureau of Fisheries are also excluded. The total of these excluded miscellaneous employments and enlistments is approximately 4,444, as compared with 4,524 for the fiscal year 1917. At the close of the fiscal year 1918 there were 832 employees in the service of the Department serving under temporary appointment or employment.

The total number of permanent positions referred to in the accompanying table, together with the employments and enlistments just mentioned, on July 1, 1918, was approximately 11,051 as compared with 10,079 on July 1, 1917. This includes 1,372 positions the incumbents of which have been temporarily transferred to the War or Navy Departments.

Bureau.	Statutory.	Non-statutory.	Total.	In District of Columbia.	Outside District of Columbia.	Increase (+) or decrease (-).
Office of the Secretary.....	178	.....	178	178	.....	+ 6
Bureau of the Census.....	609	788	1,397	• 713	684	+150
Bureau of Foreign and Domestic Commerce.....	113	107	220	• 171	49	- 13
Bureau of Standards.....	342	719	1,061	914	147	+543
Bureau of Fisheries.....	405	15	420	82	338	- 32
Bureau of Lighthouses.....	56	5,767	• 5,823	43	5,780	+110
Coast and Geodetic Survey.....	313	227	540	• 341	199	-260
Bureau of Navigation.....	• 44	180	233	35	198	+ 68
Steamboat-Inspection Service.....	264	83	347	13	334	+ 26
Total.....	2,324	7,895	10,219	2,490	7,729	+806

• Employees engaged in work in the field for a part of each year, with headquarters in Washington, are treated as within the District of Columbia.

• Includes the following positions, appointment to which is not made by the head of the department: 409 (259 classified competitive and 150 classified excepted) mechanics, skilled tradesmen, and laborers employed in field construction work in the Lighthouse Service and work of a similar character at the general lighthouse depot at Tompkinsville, N. Y.; 1,523 laborers in charge of post lights; and 1,376 members of crews of vessels.

• Includes 2 stenographers and typewriters authorized by law, and not to be employed exceeding 6 months.

The classification under the civil-service rules, by bureaus and according to authorization (statutory or nonstatutory), of the positions of a permanent nature shown in the preceding table is given in the table below:

	Office of the Secretary.	Bureau of the Census.	Bureau of Foreign and Domestic Commerce.	Bureau of Standards.	Bureau of Fisheries.	Bureau of Lighthouses.	Coast and Geodetic Survey.	Bureau of Navigation.	Steamboat-Inspection Service.	Total.
Classified service:										
Competitive—										
Statutory—										
In District of Columbia.....	133	604	108	320	71	35	182	27	12	1,492
Outside District of Columbia.....					298	17		15	240	570
Nonstatutory—										
In District of Columbia.....		20	27	535	1	4	21	6		614
Outside District of Columbia.....			19	147	5	2,487	67	142	82	2,961
Total.....	133	624	154	1,002	375	2,543	270	191	335	5,627
Excepted—										
Statutory—										
In District of Columbia—										
Presidential.....						4				4
Other.....	4		1		1		1	1		8
Outside District of Columbia.....					17					17
Nonstatutory—										
In District of Columbia.....			31	4	1					36
Outside District of Columbia.....			30		2	377	11	35		455
Total.....	4		62	4	21	381	12	36		830
Unclassified service:										
Statutory—										
In District of Columbia—										
Presidential.....	2	1	3	2	2		125	1	1	137
Other.....	39	4	1	20	6		5			75
Outside District of Columbia—										
Presidential.....									11	11
Other.....					10					10
Nonstatutory—										
In District of Columbia.....		84		33			7			124
Outside District of Columbia.....		684			6	2,899	121	5		3,715
Total.....	41	773	4	55	24	2,899	258	6	12	4,072
Grand total.....	178	1,397	220	1,061	420	5,823	540	233	347	10,219

* 72 per cent of the classified excepted positions consist of those of laborers in charge of lights in the Lighthouse Service with compensation of \$300 or less per annum.

† 91 per cent of the unclassified positions consist of those of special agent (cotton) in the Census Bureau; post-light keepers in the Lighthouse Service; and crews of vessels in that Service, in the Coast and Geodetic Survey, and in the Bureaus of Fisheries and Navigation, which positions have not been considered suitable for civil-service classification by reason of the nature and conditions of employment.

CHANGES IN THE PERSONNEL.

The following tables give a summary of changes in the personnel of the Department for the fiscal year ended June 30, 1918:

APPOINTMENTS, PROMOTIONS, AND REDUCTIONS.

Bureau.	Appointments.*						Promo- tions.	Reduc- tions.
	Permanent.				Tempo- rary.	Grand total.		
	Com- peti- tive.	Ex- cepted.	Un- classi- fied.	Total.				
Office of the Secretary.....	59	.....	8	67	77	144	45	1
Bureau of the Census.....	88	.....	233	321	212	533	130	1
Bureau of Foreign and Domestic Commerce.....	158	76	.....	234	60	294	153	8
Bureau of Standards.....	433	10	70	513	1,070	1,583	586	8
Bureau of Fisheries.....	37	8	8	48	103	151	43	.....
Bureau of Lighthouses.....	384	70	.....	454	385	839	887	122
Coast and Geodetic Survey.....	47	.....	6	53	175	228	212	4
Bureau of Navigation.....	46	25	5	76	77	153	84	.....
Steamboat Inspection Service.....	57	1	.....	58	47	105	40	.....
Total.....	1,309	135	330	1,824	2,106	3,930	2,187	144

SEPARATIONS AND MISCELLANEOUS CHANGES.

Bureau.	Separations. ^d					Miscellaneous changes. ^e	
	From permanent positions.				Grand total.		
	Competitive	Excepted.	Unclassified.	Total.			
Office of the Secretary.....	63	2	10	75	38	113	10
Bureau of the Census.....	95	.....	148	243	212	455	26
Bureau of Foreign and Domestic Commerce.....	91	18	.....	109	17	126	34
Bureau of Standards.....	241	17	30	288	469	757	21
Bureau of Fisheries.....	102	2	14	118	44	162	17
Bureau of Lighthouses.....	448	48	.....	496	190	686	75
Coast and Geodetic Survey.....	59	.....	2	61	69	130	21
Bureau of Navigation.....	34	5	1	40	37	77	8
Steamboat-Inspection Service.....	62	.....	.....	62	17	79	6
Total.....	1,195	92	205	1,492	1,093	2,585	218

^a Includes appointments of the following character: Presidential, by selection from civil-service certificates, under Executive order, to excepted positions, by reinstatement and by reason of transfer within the Department or from other departments or independent establishments.

^b Mainly voluntary reductions accepted by employees to secure more desirable conditions of living.

^c Includes 466 temporary increases in the personnel of the Lighthouse Service.

^d Includes separations by reason of resignations, discontinuances, removals, deaths, transfers within the Department, and transfers from the Department to other departments or independent establishments.

^e Includes reappointments by reason of change of station, name, designation, or appropriation, extensions of temporary appointments, changes from temporary to permanent status, etc.

With a view to eliminate detail work, as well as to avoid the difficulty frequently encountered by employees of the Lighthouse Service in subscribing oaths of office, a plan has been adopted whereby all classes of keepers and crews of tenders and light vessels may be given increase of compensation or transfer to other stations without further appointments, thereby avoiding the necessity of new oaths of office whenever such changes are made.

PROMOTIONS.

It has been the aim of the Department to encourage its employees to acquire in pursuance of their duties as thorough a knowledge of the operations of the various services as possible, in order that when-

ever vacancies occur in higher grade positions they may be filled by promotion rather than by the appointment from other sources of persons who are unfamiliar with the particular lines of work to be done. This policy is not only conducive to efficiency, but by reason of having competent employees ready to assume the duties of higher positions under present extraordinary conditions it has enabled the Department largely to prevent a serious demoralization of the work owing to the unusually heavy drain on its trained force by reason of separations. How serious this drain has been is shown by the fact that 1,615 out of a total force of 6,398 regularly appointed employees, or over 25 per cent, left the service during the past year.

There were only seven transfers from other departments or independent offices at a compensation greater than the usual entrancesalary, and in each case it was specifically shown that the vacancies could not be adequately filled by promotion or transfer within the Department.

The following promotions to some of the more important offices might be mentioned:

Chief of Bureau of Foreign and Domestic Commerce (presidential).—By promotion from First Assistant Chief.

First Assistant Chief of Bureau of Foreign and Domestic Commerce (presidential).—By promotion from Second Assistant Chief.

Second Assistant Chief of Bureau of Foreign and Domestic Commerce (presidential).—By promotion from special agent.

Supervising inspector, fifth district, Steamboat-Inspection Service (presidential).—By promotion from local inspector of hulls.

Supervising inspector, eighth district, Steamboat-Inspection Service (presidential).—By promotion from local inspector of hulls.

Chief Clerk and Superintendent (of Department).—By promotion from clerk, acting as assistant to the Chief Clerk and Superintendent (of Department).

Disbursing Clerk (of Department).—By promotion from clerk, acting as deputy disbursing clerk.

Chief of Division of Publications (of Department).—By promotion from Assistant Chief of Division of Publications.

Chief Statistician, Bureau of Census.—By promotion from chief clerk (of Bureau).

Chief clerk, Bureau of the Census.—By promotion from clerk, acting as assistant to the chief clerk (of Bureau).

During the fiscal year the Department authorized a total of 2,187 promotions and increases in pay as compared to 1,526 in 1917, 1,376 in 1916, and 838 in 1915. Many of these increases were necessary in order to make the pay of employees in certain services more nearly commensurate with that paid for similar work elsewhere, and thus prevent defections which threatened to paralyze the work of the service.

Fourteen employees of the Department were competitors in the various promotion examinations conducted by the Civil Service Commission during the past fiscal year, with the following results:

Examination	Passed	Failed.
Clerk (first grade).....	1	5
Clerk (typewriter).....	3	2
Total	4	10

* All have since been promoted.

In view of the unusual conditions prevailing the commission has authorized the promotion of minor clerks from \$900 to \$1,000 per annum without further examination.

LEAVES OF ABSENCE.

The following table shows, by bureaus, the total and average amount of annual and sick leave, stated separately and together, taken by the employees of the Department in the District of Columbia, arranged according to sex, during the calendar year 1917; also shows the average leave, by bureaus, as compared with 1916. The averages for 1917 show a decrease of 1.72 days of annual leave, and 0.4 day sick leave over the average for 1916. The total average of annual and sick leave for 1917 is 33.30 days against 35.42 days for the year 1916, or a decrease of 2.12 days.

TOTAL AND AVERAGE AMOUNT OF ANNUAL^a AND SICK LEAVE, BY BUREAUS, STATED SEPARATELY AND TOGETHER, TAKEN BY THE EMPLOYEES OF THE DEPARTMENT IN THE DISTRICT OF COLUMBIA, ARRANGED ACCORDING TO SEX, DURING THE CALENDAR YEAR 1917, AND AVERAGE LEAVE FOR 1916.

MALE.

Bureau.	Number.	Annual leave.		Sick leave.		Total.		Average, 1916.
		Days.	Average.	Days.	Average.	Days.	Average.	
Office of the Secretary.....	77	1,864	24.21	334½	4.34	2,198½	28.55	33.59
Bureau of the Census.....	279	7,954	28.51	1,763	6.32	9,717	34.83	36.76
Bureau of Foreign and Domestic Commerce.....	74	2,067	27.93	536	7.24	2,603	35.17	35.69
Bureau of Standards.....	268	5,635	21.03	954½	3.56	6,590½	24.59	31.33
Bureau of Fisheries.....	51	1,280	25.09	287½	5.63	1,567½	30.72	28.92
Bureau of Lighthouses.....	24	694	28.91	117	4.87	811	33.78	35.80
Coast and Geodetic Survey....	146	3,916	26.82	792	5.42	4,708	32.24	33.83
Bureau of Navigation.....	20	547	27.35	96½	4.82	643½	32.17	31.58
Steamboat-Inspection Service	8	226	28.25	6	.75	232	29.00	29.44
Total and average.....	947	24,184	25.54	4,887	5.16	29,071	30.70	33.88

FEMALE.

Office of the Secretary.....	39	1,134	29.08	242½	6.21	1,376½	35.29	37.22
Bureau of the Census.....	228	7,773	29.97	2,685½	11.88	9,458½	41.85	40.59
Bureau of Foreign and Domestic Commerce.....	12	357	29.75	94½	7.87	451½	37.62	37.46
Bureau of Standards.....	2	60	30.00	58	29.00	118	59.00	29.00
Bureau of Fisheries.....	19	559	29.42	231	12.15	790	41.57	35.65
Bureau of Lighthouses.....	2	60	30.00	47	23.50	107	53.50	50.00
Coast and Geodetic Survey....	15	443	29.53	191½	12.76	634½	42.29	40.15
Bureau of Navigation.....	~	87	29.00	41½	13.83	128½	42.83	43.80
Steamboat-Inspection Service								
Total and average.....	318	9,473	29.79	3,591½	11.29	13,064½	41.08	39.85

TOTAL.

Office of the Secretary.....	116	2,998	25.84	577	4.97	3,575	30.81	34.78
Bureau of the Census.....	505	14,727	29.16	4,448½	8.91	19,175½	37.97	38.55
Bureau of Foreign and Domestic Commerce.....	86	2,424	28.17	630½	7.33	3,054½	35.50	35.95
Bureau of Standards.....	270	5,695	21.10	1,012½	3.75	6,708½	24.85	31.39
Bureau of Fisheries.....	70	1,839	26.27	518½	7.40	2,357½	33.67	30.81
Bureau of Lighthouses.....	26	754	29.00	164	6.30	918	35.30	37.06
Coast and Geodetic Survey....	161	4,359	27.07	983½	6.10	5,342½	33.17	34.30
Bureau of Navigation.....	23	634	27.56	138	6.00	772	33.56	34.13
Steamboat-Inspection Service	8	226	28.25	6	.75	232	29.00	29.44
Total and average.....	1,265	33,657	26.60	8,478½	6.70	42,135½	33.30	35.42

^a In the count of the annual leave all periods of one-half day and over were counted as a full day; periods of less than one-half day were omitted.
^b Only those employees are included who were considered as being entitled to the full yearly allowance of both annual and sick leave.

The following statement, based on the percentages of the preceding table, shows the relative standing of the bureaus for the calendar years 1917 and 1916 with respect to the lowest average amount of leave used.

The Bureau of Standards has the lowest average per employee of both annual leave and of annual and sick leave combined. The Steamboat-Inspection Service retains the premier position held by it in 1916 and 1915 as having the lowest average of sick leave.

RELATIVE POSITIONS OF BUREAUS FOR 1917 AND 1916 WITH REGARD TO THE USE OF THE LEAVE PRIVILEGES.

Bureau.	Annual leave.		Sick leave.		Total.	
	1917	1916	1917	1916	1917	1916
Office of the Secretary.....	2	4	3	8	3	6
Bureau of the Census.....	9	8	9	9	9	9
Bureau of Foreign and Domestic Commerce.....	6	7	7	6	8	7
Bureau of Standards.....	1	3	2	2	1	3
Bureau of Fisheries.....	3	1	8	3	6	2
Bureau of Lighthouses.....	8	9	6	7	7	8
Coast and Geodetic Survey.....	4	5	5	5	4	5
Bureau of Navigation.....	5	6	4	4	5	4
Steamboat-Inspection Service.....	7	2	1	1	2	1

Another statement prepared in this Division shows that only 58 per cent of the total number of employees considered (1,265) took all of their annual leave, as compared with almost 67 per cent in 1916; that only 4 per cent took all their sick leave, against 5 per cent in 1916; that 33 per cent took no sick leave, against 29 per cent in 1916; and that 3½ per cent took all their annual and sick leave, against 4 per cent in 1916. Thirteen employees were reported as taking no annual or sick leave during the year.

In February last, following the practice of the Department, an examination was made of the leave record of all employees for the past three years. The examination showed that only 13 employees (a decrease of 10 employees for 1914, 1915, and 1916) in three bureaus took substantially all of their annual and sick leave during the calendar years 1915, 1916, and 1917.

The names of these employees were brought to the attention of the bureau chiefs concerned. After considering each case thoroughly, steps were taken which, it is believed, will have a tendency to reduce the excessive amount of leave taken wherever it was considered there might be a disposition to abuse the sick-leave privilege.

In order to attract to the service the best class of men available under prevailing conditions, the Department has modified its leave regulations pertaining to the Lighthouse Service so as to allow a considerably longer period of annual leave to keepers of isolated light stations where family quarters are not provided and also to the officers and crews of isolated light vessels. It has also modified the leave regulations pertaining to per diem employees so that Service to avoid any undue hardships, so as to permit the granting of leave in periods of not less than one-half day in lieu of one day, as heretofore.

OFFICIAL BONDS.

The following table shows, as of June 30, 1918, the character, number, and penalty of bonds of officers of this Department required by law or regulation and the number of each kind given during the fiscal year ending on that date:

Bonded as—	Total number bonded.	Number bonded during fiscal year.	Aggregate penalty.	Statute or regulation requiring bond.
Disbursing clerk, Department of Commerce. ^a	1	-----	\$50,000	Sec. 176, R. S.
Special disbursing agent.....	59	16	500,000	Sec. 3614, R. S.
Chief of party, Coast and Geodetic Survey	60	27	250,000	Sundry civil appropriation act, approved July 1, 1918, and prior years.
Shipping commissioner, Bureau of Navigation.	14	3	70,000	Sec. 4502, R. S., as amended by the act of Apr. 26, 1906 (34 Stat., 137).
Hydrographic and geodetic engineer in charge of office, Coast and Geodetic Survey.	1	1	2,000	Par. 370, Regulations and Instructions for the Government of the Coast and Geodetic Survey, effective Jan. 1, 1913.
Total.....	135	47	941,000	

^a The bond of the disbursing clerk of the Department is subject to the approval of the Secretary of the Treasury, and all records pertaining thereto are maintained by the Treasury Department.

^b The number of bonded officers of the Coast and Geodetic Survey was reduced during the fiscal year through the transfer of 45 employees to the service and jurisdiction of the War and Navy Departments by Executive order.

^c Includes 24 bonds given for the purpose of renewal or change in amount of penalty.

COMPILATION OF DATA RELATING TO THE PERSONNEL.

The Division is frequently called upon to compile statistics relating to the personnel. The varied character of the data furnished may be seen from the following brief description of some of the statements prepared during the past fiscal year:

Officials in Alaska.

Field officers of the Bureau of Foreign and Domestic Commerce.

Officials located in Pennsylvania.

Employees serving in Detroit, Mich.

Presidential officers of the Department.

Number of appointments and separations, by bureaus, during a certain period.

Number of clerks and stenographers in a certain bureau appointed at more than the usual entrance salary (\$900).

Number of separations during 1917.

Officials appointed from Michigan.

Number of employees subject to draft under the selective-service act.

Nationality of employees of a certain bureau.

Employees appointed from South Dakota.

Employees in the District of Columbia appointed from Indiana.

Employees with ability to translate foreign languages.

Female employees in the District of Columbia.

Number of employees who have entered the military and naval services.

Statement showing (1) all promotions and increases in salary during 1917; (2) all transfers to Department; (3) all transfers from Department; and (4) all transfers within Department.

Names of employees in various bureaus with sufficient stenographic ability to record hearings, etc.

Detailed data concerning annual and sick leave taken in 1917 by employees in the District of Columbia.

Employees appointed from North Carolina.

Number of women appointed from Illinois during a certain period.

Total number of women appointed in the Department during a certain period.

Statistical data concerning regular and special disbursing agents, the amounts of their bonds, etc.

Names of employees receiving a nominal salary, with home addresses and business connections.

Number of employees, by bureaus, in the District of Columbia and in the field.

DECISIONS OF THE COMPTROLLER OF THE TREASURY.

The following decisions affecting the personnel were rendered to the Secretary of Commerce by the Comptroller of the Treasury during the past fiscal year:

July 23, 1917.—Payment of the 5 and 10 per cent increases of compensation is authorized under section 2 of the sundry civil appropriation act of June 12, 1917, in the case of temporary employees of the Department of Commerce, if the rates of compensation received by such employees are fixed by law or regulation and not by mere agreement made at the time when the services are engaged. The fact that such compensation is measured by the prevailing local rate and that the appointments are not made by the Washington office is not material.

July 27, 1917.—Under the act of May 22, 1917, providing for the promotion of aids and assistants to the positions of junior hydrographic and geodetic engineer, and hydrographic and geodetic engineer, respectively, but making no provision with reference to promotion from one rate of compensation to another within said designations, the Secretary of Commerce is authorized to designate persons properly holding a commission as hydrographic and geodetic engineer or junior hydrographic and geodetic engineer, to receive the salaries provided for such positions in the act of June 12, 1917.

October 17, 1917.—Since, under existing law, per diem employees are entitled to holidays absolutely and not in the discretion of an administrative officer, they may not by contract be limited, in the compensation received for work on such days, to the rate specified for actual employment.

October 17, 1917.—In fixing the compensation of employees paid from lump-sum appropriations, under original appointment, the percentage increases of compensation authorized for other positions can not be considered for the reason that such increases relate only to the present fiscal year and are not a part of the regular compensation of employees receiving same.

October 18, 1917.—By the transfer to the War and Navy Departments of certain officers and men of the Coast and Geodetic Survey, under the Executive order of September 24, 1917, the authority of the Coast and Geodetic Survey terminated as of the close of the preceding day, and, accordingly, expenses of travel, salaries, and subsistence of the officers and men so transferred are payable on and after that date by the department to which transferred.

November 21, 1917.—The Coast and Geodetic Survey is authorized to fill, by appointment or promotion, such vacancies as may have occurred in its personnel due to the transfer of members thereof to the War and Navy Departments under the Executive order of September 24, 1917 (promulgated under authority of the act of May 22, 1917), the individual and not the office having been transferred under that order.

November 21, 1917.—Temporary appointments and promotions may be made to fill vacancies occurring in the Coast and Geodetic Survey due to the transfers made under the provisions of the Executive order of September 24, 1917 (promulgated under authority of the act of May 22, 1917).

SUPERANNUATION AND RETIREMENT.

By an act of Congress approved June 20, 1918, authority has been given for the retirement on pension of superannuated employees of the Lighthouse Service. Retirement is voluntary after 65 years of age with 30 years of service; compulsory after 70 years of age. The payment authorized is one-fortieth of the average annual salary during the last five years of service for each year of total service rendered, not exceeding a maximum of three-fourths of such

average annual salary. This may first be viewed as a recognition—tardy, but none the less welcome—of faithful and efficient service, frequently involving discomfort, hardship, and danger. In a larger sense this legislation may be considered as an acceptance of the principle of the retirement on pension of the superannuated civil employees of the United States. It may be viewed as the first ray of light appearing on the horizon heralding, it is hoped, the dawn of the day when the sun of retirement pensions will shed its comforting rays on all classes of superannuated Government employees.

SALARIES.

The 5 and 10 per cent increase for the fiscal year 1918 has been replaced by a straight \$120 per annum increase (with certain exceptions) for all those filling what may be considered permanent positions. While this is more equitable to those receiving small salaries, it is only a slight and temporary palliation of the hardship resulting from the constantly increasing cost of living. The average salary of the Government employee has been estimated to be less than \$1,200 per annum, and with the \$120 per annum increase his earnings are augmented approximately 10 per cent over a standard which has remained practically unchanged for decades, while during the last 10 years the cost of living has increased almost twofold, for considering the standard of prices in 1907 as 100 per cent, the same on June 30, 1917, would be represented by 197 per cent.

Owing to the constantly increasing cost of living it has been necessary for the Department to make substantial increases in the subsistence allowances of officers and crews of the Lighthouse Service, Bureau of Fisheries, and the Coast and Geodetic Survey. Subsistence allowance of lighthouse keepers has been increased by act of Congress from 30 to 45 cents per day.

In many sections of the Department's service and where appropriations permit it has been necessary to increase salaries in order to retain and obtain efficient employees to maintain operations. The scale of wages established for certain classes of work outside the governmental service is higher than that which it is possible for the Department to offer. No result can be anticipated other than that the trained employees of the Department will seek better paid positions, with the further result that the Government's operations will have to be carried on by inexperienced people, involving a slowing up of the work, errors of commission and omission, and the period of training for the new employee. Each of these factors is costly, and this should demonstrate that a low salary scale is not conducive to the economy and efficiency which should be the aim of the Government as well as of business agencies.

An unskilled laborer outside the service of the Government can now earn wages equal to the salary of the average Government clerk who has rendered several years' service.

The activities of some of the units of the Department are very seriously handicapped, as, working with statutory positions, it is possible to offer new appointees only such low salaries as are inadequate to provide decent maintenance, and as a consequence appointees promptly relinquish their appointments, and a dangerously large

proportion of temporary appointees, possessing a lower standard of qualifications, have to be made use of. The salary question should be handled as a matter of serious study and not in such a way as to remind one of the doctor who prescribed 5 grains of quinine for every patient.

CIVIL-SERVICE METHODS.

From numerous inquiries made there appears to be a general impression that the civil-service rules have been relaxed so as to permit appointments in this Department without regard to examinations. This is not correct, however, as all appointments have been made through the usual civil-service channels, although a few have been authorized under the Executive order of March 26, 1917, which provides that "when the Civil Service Commission decides that, because of a public exigency, there is need of the immediate filling of a position for which there is no suitable eligible, the commission may authorize the filling of such position by the appointment of a person shown to be qualified by such noncompetitive tests of fitness as the commission may prescribe."

In each instance the position was of such a nature as to require a prompt appointment and to preclude selection after open competitive examination, suitable tests of fitness being furnished the commission as it requested.

Owing to the growing scarcity of labor and the increasing demand for help from all sources, it has been impossible for the Civil Service Commission to provide a sufficient number of eligibles for probational appointment, and it was therefore necessary to fill a great many positions temporarily until such time as the commission may be able to provide eligibles. During the past fiscal year the Department made 2,106 temporary appointments as compared with 944 during the fiscal year 1917. In order to avoid unnecessary detail work in connection with making such temporary appointments the commission granted the Department general authority to fill positions temporarily outside the registers, provided that informal inquiry made at the time showed that there were no eligibles on the registers available for temporary service.

During the year the Civil Service Commission conducted 41 examinations for the purpose of establishing special registers for the Department. The Department made 893 requisitions upon the commission for eligibles but received only 757 certifications, and it was consequently necessary, as stated, to make a considerable number of temporary appointments. In doing so the Department was greatly assisted by taking applicants for employment from those who had registered their names with the local office of the United States Employment Service.

The Department fully appreciates the very earnest efforts made by the Civil Service Commission to provide qualified eligibles through examination, and as a means of meeting existing conditions has requested the commission to change a number of examinations from the "assembled" to the "nonassembled" type.

THE EFFECT OF THE WAR SITUATION ON THE PERSONNEL

While several bureaus of the Department have a considerable portion of their personnel employed directly on war work, each bureau has had devolved upon it additional duties, in connection with the war situation, either by using its agencies in cooperation with the military branches of the service or by increase, consequent upon war activities, of the duties being performed by it. While in many cases this has been done without any appreciable increase of the personnel, that of the Bureau of Standards, which is engaged on scientific research and actual constructive work of varied character, has more than doubled since the United States enrolled itself among the combatants. Because of this fact and by reason of the Army draft and from other causes the work of the Appointment Division has greatly increased, the total of appointments, promotions, and separations for the fiscal year 1918 being 8,702 as compared with 5,223 for the preceding year. Nor is the numerical increase at all indicative of the increased work, as the difficulty of securing suitable eligibles willing to accept the low salaried positions increased to many times over the labor involved.

It is estimated that over 10 per cent of the Department's total force of approximately 10,000 were of draft age. The service flag flying from the Commerce Building bears the number 1,824, indicating the size of the Department's contribution of personnel to the militant forces of the Nation. The flag also carries three gold stars in memory of those in that contribution who have rendered the supreme sacrifice.

A card record of former employees serving in the Army or Navy has been prepared, and, with the cooperation of the bureaus, it is hoped to make this a live record of the Department's former employees who are taking part in the war. No exemption to the draft has been claimed for any employee. Deferred classification has been claimed and granted in less than 400 cases, these consisting almost entirely of scientists or specialized workers whose duties pertain to war work or preparations. Many employees have left to accept positions in noncombatant branches of the military service.

In the early stages of the war preparations employees separated for Army or Navy service were placed on furlough for one year, whenever this could be done without detriment to the work of the Department. Under civil-service regulations this was the maximum period permissible, and it was necessary at the end of the year to drop their names from the rolls. In order, however, to prevent these former employees from forfeiting eligibility for reinstatement, the Department took up the question of securing the necessary amendment to the civil-service rules as to reinstatement, and on July 18, 1918, an Executive order was issued whereby in cases of those leaving the classified civil service to engage in the naval or military services of the Government during the present war with Germany, and who are honorably discharged therefrom, the period of eligibility for reinstatement was extended to a period of five years after such discharge, provided that they have the required fitness to perform the duties of the positions to which reinstatement is sought.

Another result of the war situation is seen in the increase of female employees, not always from necessity, but in conformity with the instructions of the head of the Department that during the war and

until further notice, in occupations where eligible lists of women exist, to prefer women as far as possible. Hence, although the greater number of positions in the Department, particularly in the field service, are not suitable for the employment of women the Department has appointed a larger number of women than heretofore. During the fiscal year 226, or about 15 per cent, of the probational appointments were issued to women, in each instance upon the same conditions as men were appointed. The probabilities are that this percentage will be considerably increased during the present fiscal year.

Respectfully,

CLIFFORD HASTINGS,
Chief of Appointment Division.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

REPORT
OF THE
CHIEF, DIVISION OF PUBLICATIONS

835

REPORT

OF THE

CHIEF, DIVISION OF PUBLICATIONS.

DEPARTMENT OF COMMERCE,
DIVISION OF PUBLICATIONS,
Washington, September 3, 1918.

SIR: The following report concerning the work of the Division of Publications during the fiscal year ended June 30, 1918, is respectfully submitted.

DUTIES OF THE DIVISION.

The Division of Publications is charged with an economical expenditure of the printing and binding allotment of the Department. This responsibility involves the conduct of the business which the Department transacts with the Government Printing Office, and general supervision over all printing (including editing and preparing copy), illustrating, and binding for the Department, and keeping records of expenditures and incurred liabilities. The Division has in charge also the distribution of publications; the maintenance of mailing lists; the operation of duplicating, addressing, folding, sealing, and mailing equipments; the advertising done by the Department; and the correspondence which these duties entail.

The pages following epitomize the activities of the Division along these lines.

ALLOTMENT AND EXPENDITURES.

The act of June 12, 1917, making appropriations for the sundry civil expenses of the Government for the fiscal year ending June 30, 1918, and for other purposes, allotted to the Department \$400,000 for printing and binding during the fiscal year 1918. Of this sum \$394,952.24 was expended, leaving an unused balance on June 30 of \$5,047.76. The increase in expenditures in 1918 compared with 1917 was \$12,349.48 (or 3.23 per cent), the allotment in 1917 being \$400,000 and the expenditures \$382,602.76.

The estimated cost of unbilled and uncompleted work of the Department at the Government Printing Office on July 1, 1918, and chargeable against the allotment for 1919, was \$64,864.57, while such work at the Government Printing Office on the same date in 1917 actually cost \$69,104.73.

During the fiscal year 1918 the Department issued on the Public Printer 2,871 requisitions for printing and binding, compared with 2,722 during the preceding fiscal year, an increase of 149. Of the requisitions issued in 1918 there remained at the close of the fiscal year 501 on which deliveries of completed work had not been made, compared with 416 in 1917, 379 in 1916, 436 in 1915, 355 in 1914, and 344 in 1913.

COST OF PRINTING AND BINDING, BY BUREAUS.

The following table shows the cost of printing and binding for each of the bureaus, offices, and services of the Department during the fiscal years 1917 and 1918, together with the increase or decrease for

each bureau, office, and service, and the estimated cost of the work on hand but not completed June 30, 1918:

Bureau, office, or service.	Cost of work delivered.		Increase (+) or decrease (-).		Estimated cost of work not completed June 30, 1918.
	1917	1918	Cost.	Per cent.	
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$15,432.08	\$18,388.96	+\$2,956.88	+19.15	\$1,314.46
Appointment Division.....	378.00	651.23	+ 273.23	+74.59	60.64
Disbursing Office.....	696.21	564.78	- 131.43	-18.88	28.97
Division of Supplies.....	184.85	202.55	+ 17.70	+ 9.58	28.38
Bureau of the Census.....	115,971.35	96,487.31	-19,484.04	-16.80	27,654.48
Coast and Geodetic Survey.....	28,685.67	46,610.93	+16,925.26	+59.00	9,634.26
Bureau of Fisheries.....	16,432.46	15,364.28	- 1,068.18	- 6.50	963.24
Bureau of Foreign and Domestic Commerce.....	121,529.73	118,617.02	- 2,912.71	- 2.39	10,756.21
Bureau of Lighthouses.....	18,569.17	18,586.42	+ 17.25	+ .09	886.53
Lighthouse Service.....	4,771.61	6,443.82	+ 1,671.71	+35.08	1,615.30
Bureau of Navigation.....	14,740.06	12,902.86	- 1,837.20	-12.46	19.71
Shipping Service.....	2,491.36	3,440.45	+ 949.09	+38.10	1,119.73
Radio Service.....	589.98	447.29	- 142.69	-24.19	.....
Bureau of Standards.....	23,649.34	35,638.74	+11,989.40	+50.70	6,630.58
Office of the Supervising Inspector General, Steamboat-Inspection Service.....	1,009.06	1,760.34	+ 751.26	+74.45	12.48
Steamboat-Inspection Service.....	10,701.05	9,795.13	- 905.92	- 8.47	1,230.17
Customs Service.....	6,775.76	10,060.63	+ 3,274.87	+48.33	2,710.40
Total.....	382,602.76	394,952.24	+12,349.48	+ 3.23	64,964.87

SUMMARY OF EXPENDITURES, 1907-1918.

The following statement gives for each of the fiscal years 1907 to 1918 the amount available to the Department for printing and binding, the amount expended, the unused balance on June 30, and the cost of work not completed at the close of the year. Figures prior to 1913 include expenditures for bureaus and services transferred to the Department of Labor by the act of March 4, 1913, but do not include those for the Bureau of the Census, which was formerly provided for by separate allotments or appropriations. Expenditure for the Bureau of Corporations also are included in years prior to 1916.

Fiscal year.	Allotment.	Expenditures.	Unused balance.	Cost of work not completed June 30.
1907.....	\$375,000.00	\$332,185.05	\$42,814.95	\$34,749.24
1908.....	375,000.00	342,982.36	32,017.64	47,053.59
1909.....	375,000.00	374,939.91	60.09	26,139.28
1910.....	a 376,337.43	a 361,530.43	14,807.00	42,538.98
1911.....	b 381,500.00	b 375,575.02	5,924.98	46,173.12
1912.....	375,000.00	374,995.64	4.36	43,966.76
1913.....	c 329,978.06	c 329,974.92	3.14	36,688.69
1914.....	441,000.00	410,700.77	30,299.23	48,837.74
1915.....	400,000.00	399,999.47	50.53	55,963.72
1916.....	390,000.00	389,683.28	161.72	68,771.61
1917.....	400,000.00	382,602.76	17,397.24	69,194.73
1918.....	400,000.00	394,952.24	5,047.76	a 64,964.87

a Includes \$1,337.43 expended for supplies furnished the Bureau of the Census, for which the Department's allotment was reimbursed.

b Includes a special appropriation of \$6,500 for the printing of the World Trade Directory. The entire sum was expended for the publication.

c The Department's allotment was reimbursed for printing and binding furnished the Bureau of Navigation for the Radio Service, costing \$1,716.58, from the appropriation "Enforcement of wireless-communication laws, 1913"; also for work furnished the Bureau of the Census, costing \$5,011.45, of which \$383.20 was reimbursed from the appropriation "Tobacco statistics, Bureau of the Census, 1913," and \$4,628.19 from the appropriation "Cotton statistics, Bureau of the Census, 1913."

d Estimated.

QUANTITY AND COST OF PRINTING AND BINDING, BY CLASSES.

The following statement shows the amount and cost of each class of work called for by requisitions on the Public Printer during the fiscal year 1918, and affords a comparison with the amount and cost of these classes during the preceding fiscal year:

Class.	1917	1918	Increase (+) or decrease (-).	
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Per cent.</i>
Blank forms.....	17,298,211	25,605,702	+ 8,307,491	+ 48.08
Reports, pamphlets, etc.....	4,016,515	4,560,340	+ 543,825	+ 13.54
Letterheads.....	3,562,000	3,360,000	- 202,000	- 5.67
Envelopes.....	50,000	58,000	+ 8,000	+ 16.00
Circulars, summaries, and notices.....	324,475	1,562,625	+ 1,178,150	+306.43
Index cards.....	1,837,400	1,318,500	- 518,900	- 28.24
Guide cards and folders.....	88,500	431,817	+ 343,317	+337.93
Memorandum sheets.....	1,586,000	2,240,000	+ 654,000	+ 41.24
Blank books.....	27,191	24,578	- 2,613	- 9.61
Miscellaneous books (binding).....	2,866	2,819	- 47	- 1.64
	<i>Cost.</i>	<i>Cost.</i>	<i>Cost.</i>	<i>Per cent.</i>
Blank forms.....	\$33,246.00	\$52,441.17	+ \$19,195.17	+ 57.74
Reports, pamphlets, etc.....	\$20,981.44	\$06,761.33	- 15,220.11	- 4.74
Letterheads.....	4,971.42	5,380.60	+ 409.18	+ 8.23
Envelopes.....	210.71	146.97	- 63.71	- 30.25
Circulars, summaries, and notices.....	2,118.95	4,068.12	+ 1,949.18	+ 92.70
Index cards.....	1,268.75	1,153.60	- 115.15	- 9.08
Guide cards and folders.....	857.81	2,779.80	+ 1,921.99	+224.06
Memorandum sheets.....	407.24	2,122.46	+ 1,715.22	+421.18
Blank books.....	8,190.64	14,348.41	+ 6,157.77	+ 75.18
Miscellaneous books (binding).....	9,513.53	6,055.63	- 3,457.90	- 36.35
Miscellaneous.....	\$36.27	679.14	+ 642.87	+ 17.79
Total.....	382,602.76	394,952.24	+ 12,349.48	+ 3.23

The following table gives the cost of work ordered from the Public Printer during the fiscal years 1917 and 1918, by classes and by bureaus, offices, and services:

Bureau, office, or service.	Blank forms.		Reports, pamphlets, etc.		Letterheads.	
	1917	1918	1917	1918	1917	1918
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$951.39	\$1,313.59	\$7,460.87	\$7,649.63	\$1,014.79	\$1,116.45
Appointment Division.....	204.46	350.61	74.36	54.74	5.71	13.96
Disbursing Office.....	647.75	601.87	.....	.....	16.48	.....
Division of Supplies.....	173.27	185.96	.....	.....	11.58	9.65
Bureau of the Census.....	12,113.08	19,976.97	97,473.81	74,904.00	928.04	426.96
Coast and Geodetic Survey.....	1,805.29	1,953.18	24,932.88	41,512.61	388.90	256.13
Bureau of Fisheries.....	1,863.76	998.71	13,675.48	11,262.47	125.41	136.96
Bureau of Foreign and Domestic Commerce.....	2,389.04	5,707.20	116,300.84	108,632.93	677.95	1,410.78
Bureau of Lighthouses.....	39.23	22.98	18,159.54	18,405.01	42.28	16.51
Lighthouse Service.....	2,844.84	3,433.16	150.20	96.19	676.47	650.81
Bureau of Navigation.....	283.19	335.12	14,303.72	12,435.29	52.62	46.14
Shipping Service.....	1,466.86	811.67	.....	.....	59.97	61.14
Radio Service.....	326.90	413.74	.....	.....	70.29	33.55
Bureau of Standards.....	1,826.06	5,375.12	19,658.91	24,222.67	443.77	787.44
Office of Supervising Inspector General, Steamboat-Inspection Service.....	102.45	1,138.24	820.02	547.83	52.16	31.04
Steamboat-Inspection Service.....	2,325.25	3,542.91	7,970.96	5,864.60	394.94	383.06
Customs Service.....	3,783.15	6,484.24	.....	83.36	.....	.....
Total.....	33,246.00	52,441.17	320,981.44	306,761.33	4,971.42	5,380.60

Bureau, office, or service.	Envelopes.		Circulars, summaries, and notices.		Index cards.		Guide cards and folders.	
	1917	1918	1917	1918	1917	1918	1917	1918
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$128.44	\$6.30	\$342.06	\$2,189.41	\$867.67	\$189.60	\$677.74	\$827.83
Appointment Division.....							13.44	45.42
Bureau of the Census.....			648.04	10.58	9.38	8.32		88.73
Coast and Geodetic Survey.....	19.50	31.51	47.15	3.28	14.09	3.85	8.53	6.04
Bureau of Fisheries.....			422.57	1,788.48	12.18	29.38		
Bureau of Foreign and Domestic Commerce.....	55.77	74.98		4.04	19.39	277.20	27.61	702.49
Bureau of Lighthouses.....			158.83	77.25		11.45	23.54	
Lighthouse Service.....		12.30		10.09		13.33	3.98	284.81
Bureau of Navigation.....	7.00	9.80					28.78	30.29
Shipping Service.....							4.52	
Radio Service.....							21.19	
Bureau of Standards.....		9.60			226.04	619.97	25.65	664.45
Office of Supervising Inspector General, Steamboat-Inspection Service.....							22.53	16.58
Steamboat-Inspection Service.....								3.56
Total.....	210.71	146.97	2,118.95	4,083.13	1,268.75	1,153.60	857.81	2,779.80

Bureau, office, or service.	Memorandum sheets.		Blank books.		Miscellaneous books(binding).		Miscellaneous.	
	1917	1918	1917	1918	1917	1918	1917	1918
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$346.50	\$1,406.05	\$1,570.03	\$2,274.88	\$914.59	\$810.30	\$538.00	\$504.92
Appointment Division.....				21.46		165.04	75.09	
Disbursing Office.....			27.00	63.91	4.98			
Division of Supplies.....						7.04		
Bureau of the Census.....	56.73	667.96	291.41	67.16	4,228.61	190.44	222.24	56.19
Coast and Geodetic Survey.....			631.25	1,421.47	747.72	418.83		
Bureau of Fisheries.....			327.28	297.29	5.63	855.97		
Bureau of Foreign and Domestic Commerce.....	4.01		383.26	417.29	1,671.86	1,292.10		96.08
Bureau of Lighthouses.....			16.42	24.58	129.33	20.57		
Lighthouse Service.....			949.50	1,918.19	146.62	23.94		
Bureau of Navigation.....				4.56	54.75	32.66		
Shipping Service.....			752.18	2,005.16	207.83	562.48		
Radio Service.....			171.60					
Bureau of Standards.....		48.45	164.90	2,350.43	1,302.99	1,640.61	1.00	20.00
Office of Supervising Inspector General, Steamboat-Inspection Service.....			1.75		10.17	26.65		
Customs Service.....			2,904.06	3,483.02	88.55			
Total.....	407.24	2,122.46	8,190.64	14,348.41	9,513.53	6,055.63	836.27	679.14

PUBLICATIONS ISSUED.

There is submitted on the following pages a list of publications issued by the Department during the last fiscal year and the number of each distributed up to July 1, 1918. Some of the publications listed were received too late for general distribution before the end of the year. The list is confined to publications becoming available for distribution or use during the year, and includes congressional documents emanating from the Department and for the printing of which the Department's allotment for printing and binding was drawn upon, in accordance with the provisions of Public Resolution No. 13, approved March 30, 1906.

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918.

[Unless otherwise stated, size of each publication is 5½ by 9½ inches.]

OFFICE OF THE SECRETARY.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Annual report of Secretary, 1917. 291 p. 1 pl. 2 p. of pl. 8 maps, 6 diag. 1 text fig.	3,000	2,295	\$1,586.75
\$5 per diem requirement. [App. A, Report of Secretary, 1917.] 2 p.	500	500	
Promotions in Bureau of Census. [App. B, Report of Secretary, 1917.] 4 p.	1,000	1,000	
Salaries of lighthouse inspectors. [App. C, Report of Secretary, 1917.] 3 p.	1,000	1,000	
Vessels and launches for Coast and Geodetic Survey. [App. D, Report of Secretary, 1917.] 10 p. 1 pl. 2 p. of pl. 8 maps, 5 diag.	1,000	1,000	131.91
Wages of seamen and officers in Bureaus of Lighthouses, Coast and Geodetic Survey, and Fisheries. [App. E, Report of Secretary, 1917.] 7 p.	1,600	1,600	
Annual report of Secretary, 1917 [press proof; extracts from]. 32 l.	2,000	2,000	54.74
Annual report of Chief, Appointment Division, 1917. 15 p.	350	329	219.46
Annual report of Chief, Division of Publications, 1917. [Printed also as H. doc. 763, 65th Cong. 2d sess.] 34 p.	400	240	
Reports of Department, 1917. Report of Secretary and reports of bureaus [consolidated]. [Printed also as H. doc. 852, 65th Cong. 2d sess.] 1,083 p. 1 pl. 2 p. of pl. 8 maps, 6 diag. 2 text fig. 1 poster.	500	277	42.63
List of publications of Department available for distribution. 15th edition. May 8, 1917. [Reprint.] 77 p.	1,000	1,000	394.58
Same. 16th edition. May 1, 1918. 77 p.	5,000	172	282.90
Monthly list of publications issued by Department [June, 1917-May, 1918, 12 numbers]. 48 p.	58,200	57,600	
Department circulars [all 8x10½"]:			
230, 2d edition—Bureau of Navigation. Rules to prevent collisions of vessels. June 8, 1917. 17 p.	30,000	30,000	618.51
Same [reprint].	15,000	13,000	308.26
236, 5th edition—Bureau of Navigation and Steamboat-Inspection Service. Regulation of motor boats. Sept. 27, 1917. 4 p.	5,000	5,000	41.37
Same, 6th edition. Jan. 25, 1918. 4 p.	75,000	44,056	273.39
246, 5th edition—Bureau of Fisheries, Alaska Fisheries Service. Regulations for protection of fur-bearing animals in Alaska. Mar. 16, 1918. 3 p.	3,500	2,940	20.02
248, 2d edition. Regulations governing leaves of absence. Apr. 13, 1918. 5 p.	5,000	1,500	63.32
249, 4th edition—Bureau of Navigation. Customs ports authorized to issue marine documents. Oct. 29, 1917. 1 p.	1,500	1,318	14.66
251, 4th edition—Bureau of Fisheries, Alaska Fisheries Service. Laws and regulations for protection of fisheries of Alaska. Mar. 12, 1918. 9 p.	3,500	2,606	70.44
253, 2d edition. Illegal collection or payment of political assessments and forms of political activity forbidden by civil-service law and rules. Sept. 22, 1914. [Reprint.] 2 p.	2,000	1,430	8.06
256—Bureau of Navigation and Steamboat-Inspection Service. Seamen's act. Mar. 6, 1915. [Reprint.] 19 p.	2,000	1,851	49.97
275. Stamp tax on bonds, guaranties, deeds, powers of attorney, etc.—War-revenue act. Nov. 30, 1917. 3 p.	1,500	1,383	20.88
Same, 2d edition. Feb. 9, 1918. 2 p.	1,500	594	14.85
276. Federal taxes for transportation of persons or things, and Government exemptions, under war-revenue act of Oct. 3, 1917. Feb. 9, 1918. 4 p.	2,000	1,548	21.18
277. Regulations governing transportation. June 18, 1918. 2 p.	3,000	.....	16.42
Inland water transportation. Report of Walter Parker, assistant to Secretary of Commerce for inland water transportation, to Hon. William C. Redfield, Secretary of Commerce, for six months ended Dec. 31, 1917. 11 p.	1,000	907	23.35
Inland waterway terminal development. Report of Walter Parker, assistant to Secretary of Commerce for inland water transportation, to Hon. William C. Redfield, Secretary of Commerce, Apr. 10, 1918. 10 p.	1,000	767	11.96
Catalogue of books and blanks furnished by Department of Commerce to customs officers. Mar. 11, 1918. 22 p.	1,000	2,067	83.36
Circulars of Department of Commerce in effect July 1, 1917. 184 p.	2,000	1,685	640.43
Public buildings in District of Columbia. Report of Public Buildings Commission pursuant to certain provisions of sundry civil appropriation act, approved July 1, 1916, authorizing appointment of commission to investigate and ascertain what public buildings are needed to provide permanent quarters for all Government activities in District of Columbia. Dec. 18, 1917. [Printed as S. doc. 155, 65th Cong. 2d sess.] 614 p. 1 pl. 120 p. of pl. 3 maps (in pocket), 11 diag. 160 text fig.	(a)	(a)	31.54
Supplemental estimates of appropriations, Department of Commerce, same to be made available and to remain available until expended. Apr. 5, 1917. [Printed as H. doc. 5, 65th Cong. 1st sess.] 4 p.	(a)	(a)	19.21
Estimate of appropriation for additional watchmen and guards, Department of Commerce, for balance of fiscal year 1917 and for fiscal year 1918. Apr. 9, 1917. [Printed as H. doc. 12, 65th Cong. 1st sess.] 2 p.	(a)	(a)	4.47

* None printed for the Department.

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF.
FISCAL YEAR 1918—Continued.

OFFICE OF THE SECRETARY—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Estimate of appropriation for special regulation of commerce, Department of Commerce, for fiscal years 1917 and 1918. June 27, 1917. [Printed as H. doc. 211, 65th Cong. 1st sess.] 3 p.	(e)	(e)	\$6.45
Supplemental estimates of appropriations required by Coast and Geodetic Survey for fiscal year 1918. July 10, 1917. [Printed as H. doc. 282, 65th Cong. 1st sess.] 3 p.	(e)	(e)	7.75
Supplemental estimates of appropriations, Department of Commerce, fiscal year 1918. July 10, 1917. [Printed as H. doc. 283, 65th Cong. 1st sess.] 4 p.	(e)	(e)	13.30
Estimate of appropriation for promoting development and use of internal waterways of United States. July 21, 1917. [Printed as H. doc. 282, 65th Cong. 1st sess.] 5 p.	(e)	(e)	12.70
Estimate of appropriation for construction of fireproof radio laboratory building, Bureau of Standards. July 30, 1917. [Printed as H. doc. 297, 65th Cong. 1st sess.] 3 p.	(e)	(e)	6.45
Estimate of appropriation for arranging and standardizing governmental and industrial cost-accounting methods. Aug. 3, 1917. [Printed as H. doc. 315, 65th Cong. 1st sess.] 4 p.	(e)	(e)	5.30
Letter from Secretary of Commerce relating to estimate for standardizing governmental and industrial cost-accounting methods. Aug. 26, 1917. [Printed as H. doc. 315, pt. 2, 65th Cong. 1st sess.] 1 p.	(e)	(e)	2.31
Estimate of appropriation for enlarging and improving lighthouse depot, Portsmouth, Va. Aug. 24, 1917. [Printed as H. doc. 347, 65th Cong. 1st sess.] 3 p.	(e)	(e)	6.05
Supplemental estimate of appropriation for aids to navigation in Potomac River. Sept. 10, 1917. [Printed as H. doc. 362, 65th Cong. 1st sess.] 3 p.	(e)	(e)	7.05
Letter from Secretary of Commerce, transmitting communication from Commissioner of Fisheries relating to rescue work for fishes in overflowed lands of Mississippi River Basin. Dec. 3, 1917. [Printed as H. doc. 393, 65th Cong. 2d sess.] 3 p.	(e)	(e)	14.16
Detailed statements of disbursements by Department. Dec. 11, 1917. [Printed as H. doc. 549, 65th Cong. 2d sess.] 137 p.	(e)	(e)	26.25
Claims considered, adjusted, and determined to be due claimants by Commissioner of Lighthouses, on account of damages caused by Lighthouse Service vessels. Dec. 11, 1917. [Printed as H. doc. 559, 65th Cong. 2d sess.] 2 p.	(e)	(e)	4.65
Supplemental estimates of appropriations, Department of Commerce, fiscal year 1918. Jan. 3, 1918. [Printed as H. doc. 697, 65th Cong. 2d sess.] 16 p.	(e)	(e)	102.67
Letter from Secretary of Commerce, transmitting communication from Director of Bureau of Standards, with petition for increase in pay to firemen in Bureau of Standards. Jan. 3, 1918. [Printed as H. doc. 703, 65th Cong. 2d sess.] 2 p.	(e)	(e)	2.61
Letter from Secretary of Commerce calling attention to certain items in estimates of appropriations, Lighthouse Service, fiscal year 1919. Jan. 3, 1918. [Printed as H. doc. 704, 65th Cong. 2d sess.] 15 p.	(e)	(e)	33.39
Deficiency estimate of appropriation, Lighthouse Service, for repairing and rebuilding aids to navigation on Atlantic coast damaged by ice or storm. Feb. 6, 1918. [Printed as H. doc. 911, 65th Cong. 2d sess.] 3 p.	(e)	(e)	15.67
Useless papers, Department of Commerce. Feb. 7, 1918. [Printed as H. doc. 921, 65th Cong. 2d sess.] 11 p.	(e)	(e)	29.28
Supplemental estimate of appropriation, Bureau of Standards, for standardizing and designing sugar-testing apparatus, fiscal year 1919. Feb. 11, 1918. [Printed as H. doc. 929, 65th Cong. 2d sess.] 2 p.	(e)	(e)	6.41
Supplemental estimates of appropriation, Department of Commerce, fiscal year 1918. Feb. 13, 1918. [Printed as H. doc. 948, 65th Cong. 2d sess.] 4 p.	(e)	(e)	16.95
Supplemental estimate of appropriation, Department of Commerce, fiscal year 1919. Feb. 20, 1918. [Printed as H. doc. 953, 65th Cong. 2d sess.] 3 p.	(e)	(e)	7.05
Deficiency estimate of appropriation to reimburse R. C. Hart, special disbursing agent, Department of Commerce. Mar. 13, 1918. [Printed as H. doc. 971, 65th Cong. 2d sess.] 2 p.	(e)	(e)	4.47
Communication inviting attention to deficiency estimate of appropriation for purchase of chart paper and for other necessary expenses of Coast and Geodetic Survey. Apr. 3, 1918. [Printed as H. doc. 1014, 65th Cong. 2d sess.] 3 p.	(e)	(e)	6.20
Supplemental estimate of appropriation, Lighthouse Service, fiscal year 1919. Apr. 20, 1918. [Printed as H. doc. 1062, 65th Cong. 2d sess.] 4 p.	(e)	(e)	11.32
Accidents sustained or caused by barges in tow, fiscal year 1917. May 4, 1918. [Printed as H. doc. 1077, 65th Cong. 2d sess.] 11 p.	(e)	(e)	22.35
Supplemental estimates of appropriations, Department of Commerce, fiscal year 1919. June 4, 1918. [Printed as H. doc. 1146, 65th Cong. 2d sess.] 5 p.	(e)	(e)	25.34
Supplemental estimate of appropriation for protecting seal and salmon fisheries of Alaska, fiscal year 1919. June 14, 1918. [Printed as H. doc. 1170, 65th Cong. 2d sess.] 3 p.	(e)	(e)	12.30

* None printed for the Department.

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF THE CENSUS.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Annual report of Director, 1917. 43 p. 1 text fig.	2,500	2,266	\$170.44
Instructions to enumerators, Virgin Islands, Nov. 1, 1917. 30 p. 4½x6½".....	300	300	42.81
Instructions to clerks and special agents, municipal finance. [Reprint.] 187 p. 4½x6½".....	100	100	51.53
Cotton production and distribution, season of 1916-17. (Bulletin 135.) 144 p. 14 text fig.	45,000	1,533	2,946.84
Instructions to special agents, electrical industries, 1917. 31 p. 4½x6½".....	300	300	57.13
Physicians' pocket reference to international list of causes of death. 4th edition. 1918. 28 p. 4 text fig. 3½x5".....	200,000	5,142	2,207.74
Report of committee on Fourteenth census legislation. Dec. 22, 1917. 33 p.	200	200	12.02
Legislation relating to Bureau of Census. 71 p. 7½x10½".....	100	100	472.81
General statistics of cities, 1916, including parks, playgrounds, museums and art galleries, zoological collections, music and entertainments, swimming pools and bathing beaches, and other features of recreation service. 88 p. map, 2 text fig. 9½x11½".....	4,500	4,500	1,909.66
Same [reprint].....	1,500	947	167.65
Financial statistics of cities having population of over 30,000, 1916. 375 p. map, 29 text fig. 9½x11½".....	6,500	5,666	9,462.54
Financial statistics of States, 1916. 127 p. 9½x11½".....	3,500	3,399	2,313.92
Birth statistics, for registration area of United States, 1915. 1st annual report. 78 p. 9½x11½".....	5,000	4,346	1,575.61
Official register of United States, 1917. [Biennial. Known as Blue book.] 886 p. 1 text fig. 9½x11½".....	25	25	12,568.67
Same [key to abbreviations only]. 16 p.	100	100	119.07
Census of manufactures, 1914 [all 9½x11½"]:			
Agricultural implements. 12 p.	1,700	1,180	160.98
Automobiles, including bodies and parts. 19 p. 1 text fig.	2,500	2,106	261.31
Brass, bronze, and copper products. 11 p.	2,200	1,395	145.19
Butter, cheese, and condensed milk. 23 p. 1 text fig.	5,250	4,489	394.49
Manufacture of buttons. 9 p.	1,600	1,108	121.55
Canning and preserving. 31 p. 1 text fig.	2,800	2,206	488.60
Carriages and wagons and materials. 17 p.	2,200	1,515	256.75
Cast-iron pipe. 7 p.	1,300	664	76.84
Chemicals and allied industries, including chemicals; sulphuric, nitric, and mixed acids; fertilizers; paint and varnish; explosives; dyestuffs and extracts; wood distillation; essential oils; and bone, carbon, and lamp black. 85 p. 1 text fig.	3,300	2,214	1,301.36
Clothing. 22 p.	8,500	5,314	410.38
Cotton manufactures. 53 p. 2 text fig.	3,000	2,266	569.95
Electrical machinery, apparatus, and supplies. 18 p.	2,700	1,954	226.21
Engines and machinery. 8 p.	2,000	1,506	78.95
Manufacture of gas. 26 p. 1 text fig.	2,400	1,853	432.99
Glucose and starch industry. 9 p.	1,300	533	111.95
Hosiery and knit goods. 29 p. 2 text fig.	2,500	1,919	419.46
Iron and steel, including blast-furnaces, steel-works and rolling-mill, wire, and tin-plate and terne-plate industries. 68 p. 5 text fig.	2,200	1,507	1,038.19
Leather industry, including leather, tanned, curried, and finished; boots and shoes; boot and shoe cut stock; boot and shoe findings; leather gloves and mittens; saddlery and harness; leather belting; leather goods, not elsewhere specified; pocket books; and trunks and valises. 63 p. 2 text fig.	3,200	1,817	926.43
Motorcycles, bicycles, and parts. 8 p.	1,200	739	89.21
Musical instruments, including manufacture of pianos and organs and materials; musical instruments and materials, not specified; and phonograph, graphophone, and talking-machine industry. 21 p.	2,000	1,196	298.61
Needles, pins, and hooks and eyes. 8 p.	1,100	469	92.29
Oilcloth and linoleum. 8 p.	1,000	371	99.65
Patent and proprietary medicines and compounds and druggists' preparations. 18 p.	1,700	620	258.36
Petroleum refining. 13 p.	1,600	1,038	178.00
Printing and publishing. 49 p.	7,250	3,497	844.98
Rubber industry. 15 p.	1,700	1,088	196.83
Silk industry. 24 p. 1 text fig.	2,200	1,422	382.31
Same [reprint of p. 21-22].	2,200	1,422	24.57
Slaughtering and meat packing. 26 p. 1 text fig.	3,750	2,537	372.51
Soap industry. 11 p.	1,800	901	167.54
Steam and electric cars, and railroad repair shops. 23 p.	2,500	2,088	331.09
Miscellaneous textiles, including cordage and twine, jute goods, and linen goods; flax and hemp, dressed; fur-felt hats; dyeing and finishing textiles; haircloth; mats and matting. 27 p.	1,800	1,016	877.17
Turpentine and rosin. 10 p.	1,100	826	126.26
Wool manufactures, including wool shoddy, wool pulling, and wool scouring. 48 p. 2 text fig.	2,200	1,487	685.43
Alabama. 29 p. 1 text fig.	1,100	1,035	401.56
Arizona. 15 p.	700	477	190.65
California. 68 p. 2 text fig.	2,600	2,146	1,202.93
Colorado. 29 p.	1,400	901	457.35

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF THE CENSUS—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Census of manufactures, 1914—Continued.			
Connecticut. 45 p.....	1,700	1,817	\$880.81
Delaware. 19 p.....	700	831	277.56
District of Columbia. 13 p.....	600	518	188.09
Florida. 21 p.....	1,000	818	266.36
Illinois. 65 p. 1 text fig.....	4,600	3,945	1,334.76
Iowa. 33 p.....	2,000	1,699	464.06
Kansas. 29 p.....	1,900	1,842	439.73
Kentucky. 37 p.....	1,200	1,120	285.45
Maine. 39 p.....	1,300	908	519.22
Maryland. 37 p. 1 text fig.....	1,500	1,097	548.11
Massachusetts. 79 p. 1 text fig.....	3,700	3,199	1,636.76
Michigan. 53 p. 1 text fig.....	2,900	2,288	894.57
Minnesota. 41 p. 1 text fig.....	2,200	1,689	674.27
Missouri. 43 p. 1 text fig.....	2,600	2,047	733.37
Montana. 17 p.....	1,000	776	265.96
Nebraska. 23 p.....	1,500	1,095	322.18
New Hampshire. 37 p.....	1,000	676	365.67
New Jersey. 59 p.....	2,000	1,488	973.81
New Mexico. 11 p.....	800	486	135.46
New York. 147 p. 2 text fig.....	6,500	3,996	2,638.76
North Dakota. 15 p.....	1,000	840	218.89
Ohio. 81 p. 2 text fig.....	4,500	3,691	1,634.74
Oklahoma. 23 p.....	1,400	1,070	324.72
Pennsylvania. 97 p. 2 text fig.....	6,500	5,080	2,057.01
South Carolina. 21 p.....	1,100	942	266.51
Tennessee. 31 p.....	1,500	1,209	480.85
Texas. 35 p.....	2,500	1,830	566.71
Virginia. 33 p. 1 text fig.....	1,600	978	564.41
Washington. 33 p.....	1,600	1,243	548.53
Wisconsin. 39 p.....	2,600	2,138	644.64
Deaf-mutes in United States, 1910: Analysis of census of 1910 with summary of State laws relative to deaf as of Jan. 1, 1918. 221 p. 9½x11½".....	2,000	1,263	\$,729.32

COAST AND GEODETIC SURVEY.

Annual report of Superintendent, 1917. [Printed also as H. doc. 507, 65th Cong. 2d sess.] 227 p. 3 pl. 4 p. of pl. 11 diag. 36 maps.....	2,500	1,833	\$3,074.58
General tide tables, [calendar] year 1918. (Serial 62.) 496 p. 6 diag. 1 text fig.....	2,500	2,500	4,801.67
Same [reprint].....	1,500	317	334.96
Atlantic coast tide tables for eastern North America, [calendar] year 1918; from General tide tables. (Serial 63.) 190 p. 6 diag. 1 text fig.....	6,000	3,470	865.33
Pacific coast tide tables for western North America, eastern Asia, and many island groups, [calendar] year 1918; from General tide tables. (Serial 64.) 182 p.....	14,000	13,635	1,461.61
Same [reprint].....	1,500	.....	196.83
Notice for Tide tables of 1918—Daylight-saving law. 1 p.....	.....	.....	10.14
United States coast pilot, Atlantic coast: pts. 1-2, St. Croix River to Cape Ann; [by S. M. Ackley, assisted by E. A. Anderson and John Ross]. 3d edition [revised by Herbert C. Graves, assisted by C. L. Warwick and E. Vance Miller, under direction of J. J. Gilbert]. 1911. [Reprint.] 200 p. 2 maps, 5 text fig. 8x11½".....	1,000	639	572.09
Same, supplement to 3d edition. Nov. 23, 1917. (Serial 78.) 161.....	1,200	875	36.56
Same, pt. 3, Cape Ann to Point Judith; [by Edwin H. Tillman, assisted by John Ross]. 3d edition [revised by Herbert C. Graves, assisted by C. L. Warwick and E. Vance Miller, under direction of J. J. Gilbert]. 1912. [Reprint.] 166 p. diag. 2 maps, 5 text fig. 8x11½".....	1,000	472	585.74
Same, supplement to 3d edition. Aug. 10, 1917. (Serial 71.) 191.....	1,200	1,200	45.41
Same, supplement to 3d edition. Apr. 19, 1918. (Serial 93.) 191.....	1,200	150	43.20
Same, pt. 4, Point Judith to New York; [by George H. Peters, assisted by Edwin H. Tillman and John Ross]. 6th edition [revised by Herbert C. Graves, assisted by J. T. Watkins]. 1917. [Reprint.] 263 p. 3 maps.....	1,500	1,469	558.73
Same, sec. C, Sandy Hook to Cape Henry, including Delaware and Chesapeake Bays; [by L. A. Potter, under direction of Herbert C. Graves]. (Serial 32.) 1916. [Reprint.] 284 p. map.....	4,000	126	1,265.63
Same, sec. D, Cape Henry to Key West; [by Herbert C. Graves, assisted by E. Vance Miller and J. T. Watkins]. 1913. [Reprint.] 231 p. map.....	2,000	213	628.36
Same, supplement to sec. D. Nov. 23, 1917. (Serial 76.) 221.....	1,500	1,285	56.85
Same, supplement to sec. D. May 24, 1918. (Serial 96.) 251.....	2,500	.....	83.75
Same, Pacific coast: California, Oregon, and Washington; [by R. S. Patton]. 3d edition. (Serial 69.) 1917. 285 p. 2 maps.....	5,000	1,289	2,336.36
Same, Alaska: pt. 1, Dixon Entrance to Yakutat Bay; [by Arthur J. Els, Jr.]. 6th edition. (Serial 66.) 1917. 257 p. 3 maps.....	4,000	1,240	2,240.11

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

COAST AND GEODETIC SURVEY—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Results of observations made at Survey magnetic observatory near Tucson, Ariz., 1915 and 1916; by Daniel L. Hazard. (Serial 75.) 101 p. 22 diag. 9½x11½"	900	733	\$1,288.15
Same, at Sitka, Alaska, 1915 and 1916; by Daniel L. Hazard. (Serial 84.) 96 p. 22 diag. 9½x11½"	900	75	1,511.71
Same, near Honolulu, Hawaii, 1915 and 1916; by Daniel L. Hazard. (Serial 86.) 101 p. 22 diag. 9½x11½"	900	75	1,114.35
Same, at Vieques, P. R., 1915 and 1916; by Daniel L. Hazard. (Serial 90.) 100 p. 21 diag. 9½x11½"	900	75	1,149.26
Tables for polyconic projection of maps, based upon Clarke's reference spheroid of 1866, 4th edition, 1917. (Special publication 5.) [Reprint.] 189 p. 1 text fig. 9½x11½"	1,300	326	201.35
Determination of time, longitude, latitude, and azimuth; by William Bowie. 5th edition, 1917. (Special publication 14.) [Reprint.] 177 p. 8 pl. 18 p. of pl. 9½x11½"	1,000	101	276.92
United States Coast and Geodetic Survey: Description of its work, methods, and organization. (Special publication 23.) 1916. [Reprint.] 56 p. 18 pl. 2 maps	1,000	252	83.14
United States magnetic tables and magnetic charts for 1916; by Daniel L. Hazard. (Special publication 44; serial 67.) 1917. 256 p. 5 maps in pocket	1,800	762	2,792.74
Results of magnetic observations made by Survey in 1916; by Daniel L. Hazard. (Special publication 42; serial 61.) 1917. 51 p. 8½x11½"	1,000	860	383.85
Same, in 1917; by Daniel L. Hazard. (Special publication 51; serial 88.) 1918. 64 p.	1,000	77	295.31
Triangulation in Georgia; by Clarence H. Swick. (Special publication 43; serial 65.) 1917. 66 p. 9 maps	1,500	206	665.14
Descriptions of triangulation stations in Georgia; by Clarence H. Swick. (Special publication 45; serial 73.) 43 p. 1 pl.	1,500	135	176.93
Rules and regulations for government of Washington office of Survey. Effective Oct. 1, 1917. (Serial 72.) 19 p. 3½x5½"	500	400	29.70
Supplement to Regulations and instructions for government of Survey. Jan. 1-June 30, 1917. (Serial 68.) 22 p. 9 text fig.	500	410	73.58
Same, July 1-Dec. 31, 1917. (Serial 79.) 17 p.	500	300	82.14
Lambert conformal conic projection with two standard parallels, including comparison of Lambert projection with Bonne and polyconic projections [with bibliography]; by Charles H. Deets. (Special publication 47; serial 77.) 1918. 61 p. 5 maps, 2 diag. 14 text fig. 7x10½"	1,500	1,500	719.27
Same [reprint].	1,000	80	121.99
Lambert projection tables with conversion tables: Supplement to Lambert conformal conic projection with two standard parallels; prepared by Charles H. Deets. (Special publication 49; serial 82.) 1918. 84 p. 2 text fig. 7x10½"	1,000	1,000	1,064.82
Same [reprint].	1,000	253	100.13
Lambert projection tables for United States; by Oscar S. Adams. (Special publication 52; serial 83.) 1918. 243 p. 11 text fig. 8x9½"	2,800	445	2,017.76
General theory of Lambert conformal conic projection [with bibliography]; by Oscar S. Adams. (Special publication 53; serial 92.) 1918. 38 p. 12 text fig. 5x8½"	2,500	125	234.67
Neglected waters of Pacific coast: Washington, Oregon, and California; by E. Lester Jones. (Special publication 48; serial 81.) 1918. 21 p. 6 pl. 7 maps, 1 diag. 8x10½"	1,500	1,500	324.80
Safeguard the gateways of Alaska: Her waterways; by E. Lester Jones. (Special publication 50; serial 87.) 1918. 41 p. 2 pl. 14 p. of pl. 21 maps, 4 diag. 1 poster. 8x10½"	2,000	2,000	846.12
Precise leveling in United States, 1900-1903, with readjustment of level net and resulting elevations; by John F. Hayford. Appendix 3 to Report for 1903 (reprinted in part). 1917. 240 p. 7x10"	1,000	79	831.17
Plane table manual; by D. B. Wainwright. Appendix 7 to Report for 1905. (Reprint [with corrections], 1916.) 54 p. 9 pl. 20 p. of pl. 7 litho. 1 text fig. 9½x11½"	500	132	170.00
Catalogue of charts, coast pilots, and tide tables, 1918. (Serial 70.) 1917. 230 p. 88 text fig. 8½x10½"	3,500	2,297	1,469.11
Same, supplement. Feb. 14, 1918. (Serial 85.) 4 p. 8x10½"	700	625	22.23
Classification of expenditures as to appropriation chargeable to. July 14, 1917. (Circular 48.) 4 p.	500	300	11.79
Coast Survey bulletin [issued monthly, June, 1917-May, 1918, nos. 25-36, various paging]. 125 p.	4,800	4,800	369.22

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF FISHERIES.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Report of Commissioner 1915, with appendices. 584 p. 13 pl. 16 p. of pl. 6 maps, 58 text fig.	250	108	\$481.23
CONTENTS.—Report of Commissioner of Fisheries.—Distribution of fish and fish eggs, fiscal year 1915; [by] Robert S. Johnson.—Fish ponds on farms; by Robert S. Johnson and M. F. Stapleton.—Alaska fisheries and fur industries, 1915; by Ward T. Bower and Henry D. Aller.—Pacific cod fisheries [with bibliography]; by John N. Cobb.—Explorations of United States Coast and Geodetic Survey steamer <i>Beche</i> in western Atlantic, Jan.-Mar., 1914, under direction of United States Bureau of Fisheries.—Oceanography [with bibliography]; by Henry B. Bigelow.—Survey of fishing grounds on coasts of Washington and Oregon in 1915; by Edward C. Johnston.			
Same [title-page and contents only]. 3 p.	500	26	2.00
Report of Commissioner, 1916, with appendices. 715 p. 3 pl. 34 p. of pl. map.	250	37	477.00
CONTENTS.—Report of Commissioner of Fisheries.—Distribution of fish and fish eggs, fiscal year 1916; [by] Henry O'Malley.—Alaska fisheries and fur industries, 1916; by Ward T. Bower and Henry D. Aller.—Pacific salmon fisheries; by John N. Cobb.—Fish laws of Mississippi River States; by Emerson Stringham.—Condition and extent of natural beds and barren bottoms in vicinity of Apalachicola, Fla.; by Ernest Danglede.—Fishing in Priamur district of Siberia; by John K. Caldwell.			
Bureau of Fisheries documents:			
249. Oysters and methods of oyster-culture, with notes on clam-culture; by H. F. Moore. [From Fish manual.] [Reprint.] 80 p. 4 pl. 14 p. of pl. 6 text fig.	500	167	70.30
707. Fishways; by H. von Bayer. [From Bulletin, v. 28.] [Reprint.] 19 p. 22 text fig. 74x11"	440		21.57
811. Menhaden industry of Atlantic coast [with bibliography]; by Rob Leon Greer. [App. 3, Report of Commissioner, 1914.] Reprinted with additions, 1917. 30 p. 1 pl. 6 p. of pl.	1,500	120	121.95
826. Fish ponds on farms; by Robert S. Johnson and M. F. Stapleton. [App. 2, Report of Commissioner, 1915.] Revised edition, 1917. [Reprint.] 32 p. 8 text fig.	2,000	1,412	60.57
838. Alaska fisheries and fur industries in 1916; by Ward T. Bower and Henry D. Aller. [App. 2, Report of Commissioner, 1916.] 118 p.	1,750	1,308	661.20
843. Fishes of Lahontan system of Nevada and northeastern California; by John Otterbein Snyder. Sept. 28, 1917. [From Bulletin, v. 35.] 66 p. 2 p. of pl. 9 text fig. map. 74x11"	850	709	554.03
845. Annual report of Commissioner, 1917. 104 p.	2,000	1,295	544.94
846. Distribution of fish and fish eggs, fiscal year 1917; [by] Henry O'Malley. [App. 1, Report of Commissioner, 1917.] 99 p.	1,250	1,250	849.33
849. Notes on embryology and larval development of 12 teleostean fishes; by Albert Kuntz and Lewis Radcliffe. [From Bulletin, v. 35.] 48 p. 126 text fig. 74x11"	850	730	261.41
850. Occurrence in Virginia of green-gilled oysters similar to those of <i>Mareanus</i> [with bibliography]; by Philip H. Mitchell and Raymond L. Barney. Aug. 11, 1917. [From Bulletin, v. 35.] 15 p. 74x11"	850	634	72.23
851. Nutrition of oysters: Glycogen formation and storage; by Philip H. Mitchell. Aug. 11, 1917. [From Bulletin, v. 35.] 11 p. 74x11"	850	606	73.00
852. Fish isinglass and glue; by George F. White. [App. 4, Report of Commissioner, 1917.] 15 p. 2 p. of pl.	850	860	65.50
853. Pikes: Their geographical distribution, habits, culture, and commercial importance [with bibliography]; by William Converse Kendall. [App. 5, Report of Commissioner, 1917.] 45 p. 6 text fig.	1,750	1,208	179.70
854. Economic relations, anatomy, and life history of genus <i>Lernae</i> ; by Charles Branch Wilson. Dec. 22, 1917. [From Bulletin, v. 35.] 36 p. 10 pl. 2 text fig. 74x11"	850	769	367.00
855. Myxosporidia of Beaufort region: Systematic and biologic study [with bibliography]; by H. S. Davis. Dec. 17, 1917. [From Bulletin, v. 35.] 45 p. 9 pl. 6 text fig. 74x11"	850	781	423.91
856. Food of shore fishes of certain Wisconsin lakes [with bibliography]; by A. S. Pearse. Jan. 9, 1918. [From Bulletin, v. 35.] 48 p. 1 text fig. 74x11"	850	740	322.00
857. Notes on life history of minnow <i>Gambusia affinis</i> and <i>Cyprinodon variegatus</i> [with bibliography]; by Samuel F. Hildebrand. [App. 6, Report of Commissioner, 1917.] 15 p. 4 text fig.	850	751	46.15
858. Fishes of Kentucky and Tennessee: Distributional catalogue of known species; by Barton Warren Evermann. Jan. 10, 1918. [From Bulletin, v. 35.] 76 p. 74x11"	850	771	630.30
859. Decapod crustaceans of Beaufort, N. C., and surrounding region [with bibliography]; by W. P. Hay and C. A. Shore. Apr. 6, 1918. [From Bulletin, v. 35.] 107 p. 1 pl. 14 p. of pl. 20 text fig. 74x11"	850	743	1,057.00

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF FISHERIES—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Bureau of Fisheries documents—Continued.			
860. Nutrition of oysters: Nature of so-called "fattening" of oysters; by Philip H. Mitchell. Mar. 13, 1918. [From Bulletin, v. 35.] 7 p. 7½x11".....	880	717	\$41.31
861. Rangeley Lakes, Me.; with special reference to habits of fishes, fish culture, and angling; by William Converse Kendall. May 25, 1918. [From Bulletin, v. 35.] 110 p. 4 pl. 2 p. of pl. map, 28 text fig. 7½x11".....	2,500	75	1,189.67
Economic circulars:			
12. Sea mussels: What they are and how to cook them; with 18 recipes. Mar. 24, 1914. [Reprint.] 5 p. 1 text fig.	25,000	22,752	85.31
Same [reprint].....	25,000		83.70
18. Oysters: Food that has not "gone up," little of their history and how to cook them; [by H. F. Moore]. Aug. 26, 1918. [Reprint.] 16 p.	50,000	50,000	263.10
18. Oysters: Little of their history and how to cook them; [by H. F. Moore]. [Reprinted and revised.] Mar. 14, 1918. 16 p.	50,000	5,905	268.41
22. Grayfish: Try it; it knocks H out of H. C. of L. Nov. 29, 1916. [Reprint.] 8 p. 1 text fig.	50,000	46,927	175.76
23. Sabiehal, alias black cod: Introduction to one of best and richest of American food fishes, with recipes for cooking it; [by H. F. Moore]. Mar. 8, 1917. [Reprint.] 6 p. 1 text fig.	50,000	50,000	168.06
Same [reprint].....	25,000	4,666	89.17
25. Burbot: Fresh-water cousin to cod; [by H. F. Moore]. May 9, 1917. [Reprint.] 4 p. 1 text fig.	25,000	25,000	36.26
Same [reprint].....	25,000	18,512	35.49
26. Bowfin: Old-fashioned fish with new-found use; [by E. K. Coker]. [Revised.] Jan. 28, 1918. 7 p. 1 text fig.	10,000	10,000	59.95
27. Practical small smokehouse for fish: How to construct and operate it. [Revised.] Oct. 28, 1917. 8 p. 5 text fig.	10,000	10,000	74.89
Same [second revision]. Oct. 25, 1917. 12 p. 11 text fig.	25,000	3,938	200.80
29. Why and how to use salt and smoked fish: Sixty-one ways of cooking them; [by H. F. Moore]. Aug. 8, 1917. 8 p.	50,000	50,000	174.34
Same [reprint].....	25,000	22,367	78.23
30. Possibilities of food from fish; [by H. F. Taylor]. Aug. 28, 1917. 4 p.	10,000	10,000	38.61
Same [reprint].....	10,000	4,874	18.41
31. Carp: Valuable food resource, with 23 recipes; [by H. F. Taylor]. Sept. 26, 1917. 7 p. 1 text fig.	50,000	50,000	180.73
Same [reprint].....	50,000	9,659	148.73
33. Whiting: Good fish not adequately utilized; [by H. F. Moore]. Oct. 10, 1917. 4 p. 1 text fig.	50,000	47,354	77.33
Same [reprint].....	50,000		60.75
33. Eulachon: Rich and delicious little fish; [by H. F. Moore]. Dec. 5, 1917. 4 p. 1 text fig.	25,000	25,000	45.43
Same [reprint].....	50,000	30,442	64.04
Same [reprint].....	38,000		51.33
34. Skates and rays: Interesting fishes of great food value, with 29 recipes for cooking them; [by H. F. Moore]. Mar. 20, 1918. 7 p. 1 text fig.	50,000	9,601	171.18
35. Sharks as food, with 30 recipes; [by Lewis Radcliffe]. Apr. 29, 1918. 8 p.	50,000	5,481	177.97
36. Fish roe and buckroe, with 35 recipes. [by Lewis Radcliffe]. Apr. 23, 1918. 11 p.	25,000	5,622	165.12
37. How the angler may preserve his catch; [by W. C. Kendall]. June 6, 1918. 7 p.	25,000	366	95.86
Fisheries Service bulletin [issued monthly, July, 1917–June, 1918, nos. 26–37, 8–14 p. each]. 128 p.	10,000	10,000	619.17
Proposals for supplies, Pribilof Islands, Alaska, 1918 [with contract and bond]. 116 p. 7½x10½".....	500	800	799.76
Work of Bureau and its fish-cultural station at Boothbay Harbor, Me. [Reprint.] 13 p. 6 text fig.	1,000	1,000	13.73
Quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels [issued monthly, June, 1917–May, 1918; statistical bulletins 381, 384, 388, 390, 393, 396, 399, 402, 406, 411, 412, 414]. 12 numbers. 1 sheet each. Approx. 35x14".....	4,300	4,000	490.18
Quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels and fishery products taken in Puget Sound and landed at Seattle, Wash., by collecting vessels [issued monthly, June, 1917–May, 1918; statistical bulletins 382, 385, 387, 389, 394, 397, 400, 406, 408, 410, 413, 415]. 12 numbers. 1 sheet each. 10½x8".....	4,300	4,000	101.94
Quantities and values of fresh fish handled, wholesale fish trade, New York City [issued monthly, Sept. 1917–Jan. 1918; statistical bulletins 392, 395, 398, 401, 407]. 5 numbers. 1 sheet each. 6x13".....	2,000	1,800	47.51
Quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, calendar year 1917, by months. (Statistical bulletin 403.) 1 sheet. 38x12".....	750	600	56.39
Same, by fishing grounds. (Statistical bulletin 404.) 1 sheet. 38x20".....	780	600	81.02

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF FISHERIES—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels, calendar year 1917, by fishing grounds and by months, and fishery products taken in Puget Sound and landed at Seattle, Wash., by collecting vessels, calendar year 1917, by months. (Statistical bulletin 402.) 1 sheet. 18x16"	750	600	\$33.27
Summary, by species, of distribution of fish and fish eggs by United States Bureau of Fisheries during fiscal year 1917 and comparative statement of output of fish and fish eggs for series of years. (Statistical bulletin 391.) 1 sheet. 8½x14"	500	400	13.22
Fisheries of Pacific Coast States, 1915; table showing this product in bushels and gallons; quantity and value of canned products, 1915; yield in 1883, 1892, 1896, 1899, 1904, 1906, 1915. (Statistical bulletin 388.) 1 sheet. 11x27"	2,000	1,800	59.92
Shrimp industry, South Atlantic and Gulf States, 1916; comparative statistics of shrimp catch of same for various years, 1880-1916. (Statistical bulletin 383.) 1 sheet. 12x22"	1,500	1,350	58.00

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

Annual report of Chief, 1917. 77 p.	2,500	2,500	\$263.86
Review of year's foreign trade. [From Report of Chief of Bureau, 1917.] 14 p.	200	200	5.07
Foreign tariff notes, no. 24. [From Commerce reports, Jan.-Mar. 1917.] 47 p.	1,000	873	123.42
Same, no. 25 [with cumulative index for nos. 22-25]. [From Commerce reports, Apr.-June, 1917.] 70 p.	1,000	956	199.08
Same, no. 26. [From Commerce reports, July-Sept. 1917.] 62 p.	1,000	882	149.29
Same, no. 27. [From Commerce reports, Oct.-Dec. 1917.] 62 p.	1,000	901	153.11
Need for use of our interior waterways. [From Commerce reports, June 13, 1917.] [Reprint.] 4 p.	10,000	10,000	16.44
Commerce reports [issued daily except Sundays and legal holidays, July 2, 1917-June 29, 1918, 304 issues, 16-32 p. each]. 4,912 p.	1,502,900	1,502,900	22,183.78
Same, [title-page and index to] nos. 76-152, v. 2 [series 1917]; Apr.-June, 1917. 58 p.	1,000	1,000	292.14
Same, [title-page and index to] nos. 153-228, v. 3 [series 1917]; July-Sept. 1917. 51 p.	1,000	967	312.88
Same, [title-page and index to] nos. 229-305, v. 4 [series 1917]; Oct.-Dec. 1917. 53 p.	1,000	1,000	331.36
Same, [title-page and index to] nos. 1-75, v. 1 [series 1918]; Jan.-Mar. 1918. 49 p.	1,000	1,000	310.90
Same, supplements [contain annual reports of United States consular officers on commercial conditions in foreign countries; 111 issues, various paging]. 1,615 p.	524,700	524,700	13,127.96
Same, [title-page, contents, and] index. 18 p.	1,000	1,000	104.67
Same [title-page and contents]. [Reprint.] 3 p.	1,000	1,000	7.78
Foreign commerce and navigation of United States, year ending June 30, 1917. [Printed also as H. doc. 982, 65th Cong. 2d sess.] 1,012 p. 9½x11½"	2,000	1,596	18,399.61
Separates reprinted from Foreign commerce and navigation, 1917 [all 9½x11½"]:			
Classification of countries for tables of imports and exports (Schedule C). 21	1,400	-----	6.57
Imports of merchandise, by articles and countries, 1913-1917. [Table 3.] 283 p.	800	322	229.80
Exports of domestic merchandise, by articles and countries, 1913-1917. [Table 5.] 430 p.	700	85	313.94
Imported merchandise entered for consumption in United States and duties collected thereon, 1917: Total values of imported merchandise entered for consumption, by customs districts. [Summary tables and Tables 9-10.] 39 p.	900	321	67.53
Monthly summary of foreign commerce of United States [May, 1917-Apr. 1918, 12 numbers; printed also as H. doc. 1501, pt. 11-12, 64th Cong. 2d sess., and H. doc. 601, pt. 1-10, 65th Cong. 2d sess.; all 9½x11½"]:			
May, 1917. 92 p.	2,800	2,339	1,683.00
June, 1917. 92 p.	3,000	2,942	1,705.91
July, 1917. 98 p.	2,850	2,708	1,825.47
Aug. 1917. 98 p.	2,850	2,710	1,807.56
Sept. 1917. 98 p.	2,850	2,737	1,785.06
Oct. 1917. 98 p.	2,850	2,772	1,763.74
Nov. 1917. 98 p.	2,850	2,757	1,711.78
Dec. 1917. 98 p.	3,100	2,955	1,602.23
Jan. 1918. 98 p.	2,850	2,819	1,618.23
Feb. 1918. 98 p.	2,850	2,819	1,627.46
Mar. 1918. 98 p.	2,850	2,830	1,631.94
Apr. 1918. 98 p.	2,850	2,788	1,618.88
Statistical abstract of United States, 1917. no. 40. [Printed also as H. doc. 1016, 65th Cong. 2d sess.] 804 p.	2,700	2,088	4,798.10

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Special agents series:			
141. West Indies as export field; by Garrard Harris and various American consular officers. 378 p. 1 pl. 12 p. of pl. map.....	1,000	671	\$1,585.08
143. Paper, paper products, and printing machinery in Peru, Bolivia, and Ecuador; by Robert S. Barrett. 77 p. 1 pl.	1,000	504	337.19
144. Markets for construction materials and machinery in Venezuela; by W. W. Ewing. 57 p.	1,000	317	184.96
145. Market for boots and shoes in Jamaica; by Herman G. Brock. 24 p.	1,000	385	71.65
146. Markets for agricultural implements and machinery in South Africa; by Juan Homs. 231 p. map, 6 text fig.	1,000	469	731.83
147. Electrical goods in New Zealand; by R. A. Lundquist. 47 p. 2 p. of pl.	1,000	360	183.93
148. South American markets for dried fruits; by Walter Fischer. 35 p.	1,000	370	144.85
149. Cotton goods in British India: pt. 4, Bombay Presidency; by Ralph M. Odell. 132 p.	1,000	409	500.12
150. Commercial laws of Switzerland; by Archibald J. Wolfe, supplemented and revised by Robert P. Shick and Phanor James Eder. 52 p.	1,000	343	148.37
151. Shoe and leather trade in New Zealand; by C. E. Bosworth. 31 p.	1,000	417	134.38
152. Market for boots and shoes in Peru; by Herman G. Brock. 89 p. 1 pl. 4 p. of pl.	1,000	445	320.76
153. Chilean market for paper, paper products, and printing machinery; by Robert S. Barrett. 72 p. 1 pl. 4 p. of pl.	1,000	359	341.83
154. Electrical goods in Ecuador and Peru; by Philip S. Smith. 51 p.	1,000	330	156.29
155. Electrical goods in Australia; by R. A. Lundquist. 64 p. 1 pl. 8 p. of pl.	1,000	366	314.03
156. Railway materials, equipment, and supplies in Australia and New Zealand; by Frank Rhea. 164 p. 1 pl. 10 p. of pl. 3 text fig.	1,000	525	746.55
157. Cotton goods in British India: pt. 5, Summary of trade, and pt. 6, Cotton manufacturing; by Ralph M. Odell. 57 p. 1 pl. 2 p. of pl.	1,000	357	303.79
158. Textile markets of Bolivia, Ecuador, and Peru; by W. A. Tucker. 106 p. 4 p. of pl.	1,000	633	410.88
159. Shoe and leather trade in Australia; by C. E. Bosworth. 39 p.	1,000	389	150.73
160. Construction materials and machinery in Colombia; by W. W. Ewing. 75 p. 4 p. of pl.	1,000	363	257.53
161. Shoe and leather trade in Philippine Islands; by C. E. Bosworth. 23 p. 2 p. of pl.	1,000	319	96.21
162. Colombian markets for American furniture; by Harold E. Everley. 34 p.	1,000	365	99.42
163. Paper, paper products, and printing machinery in Argentina, Uruguay, and Paraguay; by Robert S. Barrett. 166 p. 1 pl. 12 p. of pl.	1,000	275	715.95
164. Textile market of Chile; by W. A. Tucker. 52 p.	1,000	276	212.72
165. Tanning materials of Latin America; by Thomas H. Norton. 32 p. 2 p. of pl. 1 text fig.	1,000	369	101.29
166. Agricultural implements and machinery in Australia and New Zealand; by Juan Homs. 195 p. 1 pl. 8 p. of pl. 21 text fig.	1,000	275	742.62
168. Wearing apparel in Chile; by W. A. Tucker. 75 p.	1,000	331	247.60
Special consular reports:			
77. Turkish markets for American hardware; by G. B. Ravndal. 48 p.	1,000	300	152.77
78. East African markets for hardware and agricultural implements; by Henry P. Starrett. 27 p.	1,000	378	72.33
79. Olive growing in Spain: Description of varieties grown, methods of cultivation, and preparation of pickled olives; by Wilbur T. Gracey. 34 p.	1,000	453	103.23
80. Foreign markets for cotton linters, batting, and waste [compilation of reports by American consuls]. 34 p.	1,000	405	336.00
Tariff series:			
36. Customs tariff of Chile; by L. Domersatsky. Oct. 1917. 104 p.	1,000	587	907.96
37. Customs tariff of Australia; by L. Domersatsky. June, 1918. 104 p.	1,000	326	663.23
38. Tariff relations between Germany and Russia (1890-1914) [with bibliography]; by L. Domersatsky. 23 p.	950	568	83.81
Miscellaneous series:			
33. Trade of United States with world, 1914-15: Imports and exports of merchandise into and from United States, by countries and principal articles. [Reprint.] 247 p.	200	83	55.55
54. Canned foods: Modern processes of canning in United States, general system of grading, and description of products available for export; [by Dr. A. W. Bitting, through cooperation of National Cannery Association]. 79 p. 39 text fig.	1,000	508	388.94
55. Markets for American hardware in Italy, Spain, and Portugal; prepared under supervision by C. W. A. Veditz. 110 p. 6 p. of pl.	1,000	303	540.52
57. German foreign-trade organization, with supplementary statistical material and extracts from official reports on German methods; by Chauncey Depew Snow. 182 p.	1,000	804	863.80

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Miscellaneous series—Continued.			
60. Glass industry: Report on cost of production of glass in United States [with bibliography]. 430 p.	1,000	1,000	\$2,315.61
61. Commercial organizations of United States (revision of Miscellaneous series 28). Revised to July 1, 1917. 116 p.	1,000	910	1,198.67
62. Argentine market for motor vehicles; by David Beerscott. 27 p. 2 p. of pl.	1,000	371	100.50
63. Trade of United States with world, 1916-17: pt. I, Imports of merchandise into United States, by countries and principal articles. 112 p.	1,000	411	964.40
64. Wholesale prices of leading articles in United States markets, Jan. 1916-Dec. 1917. 14 p.	1,000	329	108.88
65. German trade and the war: Commercial and industrial conditions in war time and future outlook; by Chauncey Depew Snow and J. J. Kral. 236 p.	1,000	727	900.91
66. Furniture imports of foreign countries: Quantities, values, and sources of furniture imported by countries whose transactions exceeded \$500,000 in value, 1908 and 1913; by Edward Whitney. 31 p. Standard specifications and tests for Portland cement: Text as adopted by American Society for Testing Materials and by United States Government. Revised, 1917. Spanish-English edition, prepared under supervision of Bureau of Standards. (Industrial standards 1.) 47 p. 2 p. of pl. 12 text fig.	1,000	326	228.46
Monthly letter: Review of Bureau's activities at home and abroad. (July 2, 1917-June 1, 1918, 12 numbers, 15-22 p. each.) 214 p.	1,000	215	248.91
Government assistance to foreign buyers visiting United States. 4 p. 24x30 1/2"	3,800	3,800	300.65
Same (in French)	5,000	5,000	58.88
Same (in Spanish)	5,000	5,000	
Services to exporters rendered by Bureau. 20 p. 24x35 1/2"	2,000	2,000	46.04
Same (reprint).	5,000	5,000	85.96
Are you interested in Latin American trade? 4 p. 24x35 1/2"	2,000	2,000	18.41
Same (reprint).	2,080	2,000	5.19
Trade information on Far East available in Bureau. 4 p. 24x35 1/2"	2,000	2,000	17.32
Same (reprint).	2,500	2,500	5.76
Trade opportunities in France. (Confidential bulletin 34.) June 30, 1917. 42 p.	1,000	1,000	194.86
Uniform contracts and cost accounting definitions and methods: Recommendations by interdepartmental conference consisting of delegates from Departments of War, Navy, and Commerce, Federal Trade Commission, and Council of National Defense. July, 1917. 45 p.	10,000	10,000	265.02
List of publications [of Bureau] for sale by Superintendent of Documents, Government Printing Office, Washington, and by district and cooperative offices of Bureau. Corrected to Nov. 1, 1917. 11 p. 24x35 1/2"	10,000	10,000	67.01
Catalogue of Bureau publications: Review of information available to manufacturers and exporters in bulletins issued by Bureau. Mar. 15, 1918. 41 p.	5,000	5,000	227.58
Total values of imports and exports of United States [issued monthly, June, 1917-May, 1918, 12 numbers, 2 p. each]. 24 p. 9x11 1/2"	14,500	14,500	183.11
Exports of principal domestic breadstuffs, cottonseed oil, principal meat and dairy products, cotton, and mineral oils [issued monthly, May, 1917-Jan. 1918, 9 numbers, 4 p. each]. 36 p. 9x11 1/2"	10,350	10,350	481.85
Imported merchandise entered for consumption in United States and duties collected thereon during quarters ending Sept. 30 and Dec. 31, 1916, and Mar. 31, 1917. 113 p. 9x11 1/2"	880	883	1,026.16
Same, quarters ending Sept. 30 and Dec. 31, 1916, and Mar. 31 and June 30, 1917. 113 p. 9x11 1/2"	880	880	321.55
Same, quarter ending Sept. 30, 1917. 58 p. 9x11 1/2"	880	880	890.18
Same, quarters ending Sept. 30 and Dec. 31, 1917. 58 p. 9x11 1/2"	880	880	308.21
Schedule A, Classification of imports and exports of foreign commodities and laws and regulations governing preparation of monthly statement of imports and exports of foreign commodities in commerce of United States; approved May 28, 1915. [Reprint.] 30 p.	300	309	19.40
Schedule B, Classification of commodities and regulations governing statistical returns of exports of domestic commodities, and shipments between United States and its noncontiguous territory; approved May 26, 1917. [Reprint.] 23 p.	5,000	5,000	58.35
Schedule E, Classification of imports for consumption, with rates of duty, and laws and regulations governing preparation of quarterly statements; approved June 1, 1915. [Reprint.] 112 p.	500	500	36.82
Schedule governing statistical classification of imports into United States, with rates of duty, and regulations governing preparation of monthly and quarterly statements of imports and monthly statement of exports of foreign commodities. [Supersedes and combines former Schedule A, Classification of imports and exports of foreign commodities, and Schedule E, Classification of imports for consumption.] Approved June 10, 1918. 108 p.	2,000	2,008	1,282.64
Correspondence manual for use of stenographers and correspondence clerks. Jan. 1918. 24 p. 4x8 1/2"	500	500	90.55
An act to define, regulate, and punish trading with the enemy, and for other purposes. [Reprint of Public 91, 65th Cong.] 18 p.	1,500	1,500	14.90

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF LIGHTHOUSES.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Annual report of Commissioner, 1917. 101 p.	1,500	1,481	\$604.55
Letter from Secretary of Commerce transmitting items in estimates of ap- propriations for Service for fiscal year 1919, which have not been author- ized by Congress, and to request that necessary authority therefor be enacted into law. Dec. 26, 1917. [Reprint of H. doc. 704, 65th Cong. 2d sess.] 15 p.	450	450	4.89
To authorize aids to navigation and for other works in Lighthouse Service, and for other purposes. [Reprint of H. R. 7913, 65th Cong. 2d sess.] 6 p.	450	450	5.39
Notice to mariners (issued weekly, jointly with Coast and Geodetic Survey, July 6, 1917-June 28, 1918, nos. 27-52+1-26, 52 numbers). 6241	210,200	210,200	2,051.39
Same [for posting, Atlantic coast nos. 54-60, Pacific coast no. 22; 8 notices, each 10½x16"]. 81	7,400	7,400	77.25
Lighthouse Service bulletin (issued monthly, July, 1917-June, 1918, nos. 67-72, vol. 2, nos. 1-6, 12 numbers, 4-8 p. each). 56 p.	18,000	18,000	229.09
Light list, Atlantic and Gulf coasts of United States. [Includes also Porto Rico and Cuba.] Corrected to Jan. 1, 1917. [Reprint.] 392 p.	1,000	1,000	269.46
Same [Includes also Porto Rico, Virgin Islands, and Navassa Island.] Corrected to Jan. 1, 1918. 393 p.	15,000	10,533	4,294.91
Same, Pacific coast, United States, Canada, Hawaiian, [Midway, Guam] and Samoan Islands. Corrected to Jan. 1, 1918. [Of Samoan Islands only Tutuila is included in this publication.] 172 p.	2,800	2,241	813.42
Same, Great Lakes, United States and Canada. Corrected to Apr. 1, 1918. 219 p.	2,500	1,198	1,029.81
Same, upper Mississippi River and tributaries. 13th lighthouse district. Corrected to Jan. 15, 1918. 217 p. 3½x6½	1,200	773	557.60
Same, Ohio, Tennessee, Kanawha, and Monongahela Rivers. 14th light- house district. Corrected to Sept. 15, 1917. 141 p. 3½x6½	1,000	905	127.63
Same, lower Mississippi River and tributaries. 15th lighthouse district. Corrected to Nov. 15, 1917. 79 p. 3½x6½	800	794	172.71
Atlantic coast of United States, buoy list, Maine and New Hampshire. 1st lighthouse district. Corrected to May 1, 1918. 81 p.	6,500	4,444	887.81
Same, coast of Massachusetts. 2d lighthouse district. Corrected to June 1, 1918. 68 p.	6,500	4,301	757.36
Same, Narragansett Bay to Cape May, including New York Harbor. 3d lighthouse district. Corrected to May 15, 1918. 126 p.	6,700	5,064	731.30
Same, Cape Henlopen to Cape Lookout, including Chesapeake Bay and North Carolina sounds. 5th lighthouse district. Corrected to July 1, 1917. 141 p.	5,000	5,000	1,800.80
Same. Corrected to May 15, 1918. 128 p.	5,000	3,825	901.25
Same, Cape Lookout to Hillsboro Inlet. 6th lighthouse district. Cor- rected to May 1, 1918. 80 p.	4,000	2,608	387.16
Same, Florida reefs, and Gulf coast to Cedar Keys. 7th lighthouse dis- trict. Corrected to May 1, 1918. 52 p.	4,000	2,745	473.73
West Indies, buoy list, Porto Rico and adjacent islands. [Includes Guan- tanamo Bay on south coast of Cuba and Navassa Island in northwest part of Caribbean Sea.] 9th lighthouse district. Corrected to July 1, 1917. 22 p.	1,250	1,250	130.79
Same [Includes Guantanamo Bay on south coast of Cuba, Navassa Island in northwest part of Caribbean Sea, and St. Thomas and St. Croix Is- lands, Virgin Islands]. 9th lighthouse district. Corrected to May 15, 1918. 22 p.	800		26.90
Pacific coast, buoy list, Alaska. 16th lighthouse district. Corrected to June 1, 1918. 36 p.	1,000	452	262.02
Same, Oregon and Washington. 17th lighthouse district. Corrected to June 1, 1918. 56 p.	1,500	907	468.33
Same, California. 18th lighthouse district. Corrected to June 1, 1918. 32 p.	2,000	919	228.67
Pacific islands, buoy list, Hawaiian [Midway, Guam] and Samoan Islands. [Of Samoan Islands only Tutuila is included in this publication.] 19th lighthouse district. Corrected to July 1, 1917. 20 p.	1,100	1,100	187.60
Same. Corrected to Apr. 1, 1918. 20 p.	300	20	19.71
Specifications for third-class steel steam light vessels No. 103 and No. 104. 1917. 78 p.	200	200	175.12
Specifications for single-screw, steel, steam-propelled lighthouse tender Oak. 1918. 106 p.	200	200	231.30
Plans and specifications for buoys and appendages. July 1, 1917. 8 p. 20 pl.	600	600	175.43
Plans and specifications for moorings for vessels and buoys. July 1, 1917. 8 p. 9 pl.	600	600	56.49

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF NAVIGATION.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Annual report of Commissioner, 1917. [Printed also as H. doc. 585, 65th Cong. 2d sess.] 126 p.	1,000	236	\$1,580.40
48th annual list of merchant vessels of United States, with official numbers and signal letters, and lists of vessels belonging to Government, with distinguishing signals, year ended June 30, 1918. [pts. 1-5.] [Reprint.] 492 p. 8½x9½"	500	500	563.21
49th annual list of merchant vessels of United States, with official numbers and signal letters, and lists of vessels belonging to Government, with distinguishing signals, year ended June 30, 1917. [pts. 1-5.] 516 p. 8½x9½"	5,000	4,007	7,149.15
Seagoing vessels of United States, with official numbers and signal letters, 1917; pt. 6 of 49th annual list of merchant vessels of United States, year ended June 30, 1917. 124 p. 63 text fig. 8½x9½"	5,000	2,235	1,864.00
American documented seagoing merchant, gas, and sailing vessels of 1,000 gross tons and over. Dec. 1, 1917. 121.	40	40	196.27
American documented seagoing merchant vessels of 1,000 gross tons and over. [Confidential.] Jan. 1, 1918. 121.	50	50	69.28
Same. Feb. 1, 1918. 141.	50	50	56.12
Same. Mar. 1, 1918. 141.	50	50	47.52
Same, of 500 gross tons and over. [Confidential.] Apr. 1, 1918. 23 p.	75	75	120.54
Same. May 1, 1918. 25 p.	100	100	126.14
Same. June 1, 1918. 26 p.	100	100	100.28
Same. July 1, 1918. 26 p.	100	100	98.19
Amendments to Navigation laws of United States, 1915. 2d supplement. July 25, 1917. 111.	2,500	1,653	57.41
Same. 3d supplement. Nov. 7, 1917. 191.	2,500	1,521	84.63
Commercial ship radio stations of United States. [Confidential.] Edition Oct. 15, 1917. 32 p.	3,000	1,000	248.46
Radio communication laws of United States and international radio-telegraphic convention [and] regulations governing radio operators and use of radio apparatus on ships and on land. Edition July 27, 1914. [Reprint.] 104 p.	2,000	840	84.58

BUREAU OF STANDARDS.

Annual report of Director, 1917. 158 p. 1 poster.	1,500	666	\$414.34
Bulletin, v. 14, no. 1. Apr. 6, 1918. 166 p. 8 pl. 2 p. of pl. 38 text fig. 1 poster. 7x10"	1,500	262	353.61
CONTENTS.—Determination of degree of uniformity of bars for magnetic standards; [by] Raymond L. Sanford.—Thermoelectric measurement of critical ranges of pure iron; [by] George K. Burgess and H. Scott.—Study of electromagnet moving coil galvanometers for use in alternating-current measurements; [by] Ernest Welfel.—Standard substances for calibration of viscometers; [by] Eugene C. Bingham and Richard F. Jackson.—“Average eye” for heterochromatic photometry, and comparison of flicker and equality-of-brightness photometer; [by] E. C. Crittenden and F. K. Richtmyer.—Emissivity of straight and helical filaments of tungsten; [by] W. W. Coblenz.—Aneroid calorimeter for specific and latent heats; [by] Nathan S. Osborne.—Wave length of stronger lines in helium spectrum; [by] Paul W. Merrill.			
Same, v. 14, no. 2. June 17, 1918. 165 p. 2 pl. 47 text fig. 7x10"	1,500	243	299.31
CONTENTS.—Relative sensibility of average eye to light of different colors and some practical applications to radiation problems; [by] W. W. Coblenz and W. B. Emerson.—Calculation of constants of Planck's radiation equation: An extension of theory of least squares; [by] Harry M. Roeser.—Luminous radiation from black body and mechanical equivalent of light; [by] W. W. Coblenz and W. B. Emerson.—Experimental study of Fahy permeameter; [by] Charles W. Burrows and Raymond L. Sanford.—Note on electrical conduction in metals at low temperatures; [by] Francis B. Silsbee.—Reflecting power of tungsten and stellite; [by] W. W. Coblenz and W. B. Emerson.—Method for testing current transformers; [by] Francis B. Silsbee.			
Same, v. 14, no. 3. June 24, 1918. 158 p. 1 pl. 6 p. of pl. 44 text fig. 7x10"	1,800	215	296.42
CONTENTS.—Some electrical properties of silver sulphide; [by] George W. Vinal.—Axial aberrations of lenses; [by] E. D. Tillyer and H. I. Schultz.—Wave-length measurements in spectra from 5600 Å to 9600 Å; [by] W. F. Meggers.—Specific heat of liquid ammonia; [by] Nathan S. Osborne and Milton S. Van Dusen.—Latent heat of pressure variation of liquid ammonia; [by] Nathan S. Osborne and Milton S. Van Dusen.—Latent heat of vaporization of ammonia; [by] Nathan S. Osborne and Milton S. Van Dusen.—Gas interferometer calibration; [by] Junius David Edwards.—Resonance and ionization potentials for electrons in cadmium vapor; [by] John T. Tate and Paul D. Foote.			

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF STANDARDS—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Scientific papers [reprints from Bulletin; all 7x10":			
301. Aneroid calorimeter for specific and latent heats; by Nathan S. Osborne. Sept. 13, 1917. 27 p. 4 pl. 2 p. of pl. 2 text fig.	750	219	\$186.37
303. Relative sensibility of average eye to light of different colors and some practical applications to radiation problems [with bibliography]; by W. W. Coblenz and W. B. Emerson. Sept. 12, 1917. 72 p. 1 pl. 16 text fig.	750	305	478.41
306. Experimental study of Fahy permeameter; by Charles W. Burrows and Raymond L. Sanford. Aug. 27, 1917. 36 p. 1 pl. 21 text fig.	1,000	1,000	220.42
307. Note on electrical conduction in metals at low temperatures; by Francis B. Silsbee. July 23, 1917. 7 p.	1,000	294	37.23
308. Reflecting power of tungsten and tellurite; by W. W. Coblenz and W. B. Emerson. Aug. 10, 1917. 10 p. 5 text fig.	500	354	46.43
309. Method for testing current transformers; by Francis B. Silsbee. Nov. 3, 1917. 15 p. 4 text fig.	500	500	84.17
310. Some electrical properties of silver sulphide; by George W. Vinal. Nov. 24, 1917. 11 p. 2 p. of pl. 4 text fig.	750	571	79.11
311. Axial aberrations of lenses; by E. D. Tillyer and H. I. Schults. Nov. 3, 1917. 31 p. 27 text fig.	350	350	171.19
312. Wave-length measurements in spectra from 5000 Å to 9000 Å; by W. F. Meggers. Jan. 16, 1918. 27 p. 1 pl. 4 p. of pl. 2 text fig.	750	478	217.03
313. Specific heat of liquid ammonia; by Nathan S. Osborne and Milton S. Van Dusen. Dec. 13, 1917. 38 p. 4 text fig.	750	246	248.28
314. Latent heat of pressure variation of liquid ammonia; by Nathan S. Osborne and Milton S. Van Dusen. Nov. 16, 1917. 6 p.	1,000	402	33.68
315. Latent heat of vaporization of ammonia; by Nathan S. Osborne and Milton S. Van Dusen. Dec. 21, 1917. 36 p. 2 text fig.	1,000	271	225.55
316. Gas interferometer calibration; by Junius David Edwards. Dec. 8, 1917. 5 p. 1 text fig.	1,000	245	27.39
317. Resonance and ionization potentials for electrons in cadmium vapor; by John T. Tate and Paul D. Foote. Feb. 9, 1918. 8 p. 4 text fig.	1,000	1,000	33.26
318. Application of dicyanin to photography of stellar spectra; by Paul W. Merrill. Apr. 6, 1918. 21 p. 2 pl. 4 p. of pl. 1 text fig.	1,000	611	144.90
319. Instruments and methods used in radiometry, III: Photoelectric cell and other selective radiometers; by W. W. Coblenz. June 17, 1918. 32 p. 8 text fig.	1,000	120	129.22
320. Additions to formulas for calculation of mutual and self inductance; by Frederick W. Grover. June 24, 1918. 36 p.	1,000	65	241.35
321. Thermal expansion of alpha and of beta brass between 0 and 600° C., in relation to mechanical properties of heterogeneous brasses of Muntz metal type; by P. D. Merica and L. W. Schad. May 9, 1918. 22 p. 15 text fig.	1,000	219	145.80
322. Photoelectric sensitivity of bismuthinite and various other substances; by W. W. Coblenz. June 14, 1918. 14 p. 1 text fig.	500	136	43.37
323. Some characteristics of Marvin pyrheliometer; by Paul D. Foote. June 28, 1918. 32 p. 1 pl. 7 text fig.	1,000	75	181.13
Circulars [all 7x10":			
5. Testing of clinical thermometers. 3d edition. July 16, 1917. 19 p. 1 text fig.	1,000	276	90.21
9. Testing of glass volumetric apparatus. 8th edition. Mar. 31, 1916. [Reprint.] 32 p. 10 text fig.	500	71	28.36
10. Legal weight (in pounds) per bushel of various commodities. 3d edition. May 9, 1918. 19 p.	5,000	2,482	212.94
12. Standard specifications for incandescent electric lamps. 8th edition. Apr. 13, 1918. 14 p.	1,500	549	77.83
14. Analyzed irons and steels—Methods of analysis. 5th edition. Mar. 20, 1916. [Reprint.] 17 p.	1,000	661	31.96
25. Standard samples—General information. 6th edition. [Supersedes former editions numbered 1-5 under title "Standard analyzed samples, general information."] June 20, 1917. [Reprint.] 16 p.	1,000	500	23.70
Standard samples issued or in preparation. Supplement to Circular 25. Feb. 25, 1918. 4 p.	1,000	1,000	31.03
32. Standards for gas service. 3d edition. Mar. 10, 1915. [Supersedes 2d edition, Standard regulations for manufactured gas and gas service, and 1st edition, State and municipal regulations for quality, distribution, and testing of illuminating gas.] [Reprint.] 197 p.	250	211	106.00
33. United States Government specification for Portland cement. 3d edition. Jan. 18, 1917. [Reprint.] 43 p. 10 text fig.	3,000	1,015	106.33
40. Sodium oxalate as standard in volumetric analysis. 2d edition. May 15, 1913. [Reprint.] 13 p.	500	50	14.58
44. Polarimetry. 2d edition. Jan. 30, 1918. 196 p. 2 pl. 13 text fig.	1,500	1,034	1,045.33
Same [reprint].	1,500	.....	276.16
47. Units of weights and measures: Definitions and tables of equivalents. 1st edition. July 1, 1914. [Supersedes Tables of equivalents of United States customary and metric weights and measures.] [Reprint.] 68 p.	10,000	1,726	652.35

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF STANDARDS—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Circulars—Continued.			
Table of equivalents—millimeters to inches. Supplement to Circular 47. Oct. 27, 1917. 10 p.	5,000	1,993	\$112.24
54. National electrical safety code [for examination, trial, and constructive criticism]. 2d edition. Nov. 15, 1916. [Reprint.] 323 p. 16 text fig.	500	500	222.00
Index to parts 1, 2, and 3 of Circular 54, National electric safety code, 2d edition. 11 p.	15,000	7,224	300.04
55. Measurements for household. 1st edition. Aug. 28, 1915. [Reprint.] 149 p. 61 text fig.	1,000	1,000	225.84
61. Specifications and tolerances for weights and measures and weighing and measuring devices, as adopted by 11th annual conference on weights and measures of United States, held at Bureau, May 23-26, 1916, and recommended by Bureau for adoption by States. Nov. 13, 1916. [Reprint.] 44 p. 2 text fig.	900	174	82.14
63. Specification of transparency of paper and tracing cloth. 1st edition. May 17, 1917. [Reprint.] 8 p. 2 p. of pl. 2 text fig.	300	189	9.59
64. Rules and regulations for enforcement of lime-barrel act. Apr. 20, 1917. [Reprint.] 7 p.	2,500	723	18.35
65. Gas calorimeter tables. 1st edition. July 23, 1917. 19 p. 6 text fig.	500	500	106.06
Same [reprint].	500	195	23.32
Same [reprint].	500		23.30
66. Standard samples for thermometric fixed points. 1st edition. July 25, 1917. 13 p.	1,000	1,000	65.53
Same [reprint].	1,000	55	23.22
67. Wire gages. Jan. 17, 1918. 5 p.	1,000	1,000	53.31
Same [reprint].	5,000	80	30.33
68. Public utility service standards of quality and safety. 8 p.	5,000	2,062	54.17
69. Paint and varnish. 1st edition. Nov. 17, 1917. 85 p.	1,000	1,000	345.29
Same [reprint].	1,000	176	101.19
70. Materials for household. 1st edition. Dec. 5, 1917. 259 p. 11 text fig.	10,000	3,918	2,531.25
71. Rules and regulations promulgated under authority of Federal standard-barrel law. Sept. 18, 1917. 8 p.	5,000	5,000	63.30
Same [reprint].	5,000	918	34.28
72. Scope and application of national electric safety code. 1st edition. June 17, 1918. 84 p.	2,500	179	386.75
73. Copper [with bibliography]. June 26, 1918. 103 p. 1 pl. 4 p. of pl. 15 text fig.	1,000	80	663.51
74. Radio instruments and measurements [with bibliography]. Mar. 23, 1918. 330 p. 1 pl. 12 p. of pl. 199 text fig.	2,500	520	2,536.05
Same [errata]. 1 p.	2,500	2,500	7.84
Same [index]. 11 p.	2,500	2,500	36.28
75. Safety for household. 1st edition. Jan. 10, 1918. 127 p. 16 pl. 7 text fig.	10,000	5,190	1,538.90
Technologic papers [all 7x10^{1/2}]:			
16. Manufacture of lime; by Warren E. Emley. Feb. 1913. [Reprint.] 130 p. 13 pl. 8 text fig.	500	130	128.20
78. Properties of calcium silicates and calcium aluminate occurring in normal Portland cement; by F. H. Bates and A. A. Klein. June 9, 1917. [Reprint.] 38 p. 8 pl. 2 p. of pl. 1 text fig.	500	104	57.21
81. Liquid-measuring pumps; by F. J. Schlink. 2d edition. Oct. 20, 1917. [Reprint.] 27 p. 5 pl. 2 p. of pl. 11 text fig.	500	135	58.77
86. Resistance of oil to emulsification; by Winslow H. Herschel. Feb. 17, 1917. [Reprint.] 37 p. 1 pl. 7 text fig.	500	194	46.50
89. Specific gravity balance for gases; by Junius David Edwards. Feb. 22, 1917. [Reprint.] 20 p. 2 p. of pl. 4 text fig.	500	68	24.73
90. Structure of coating on tinned sheet copper in relation to specific case of corrosion; by Paul D. Merica. Apr. 21, 1917. [Reprint.] 18 p. 6 p. of pl. 1 text fig.	500	100	34.35
93. Glasses for protecting eyes from injurious radiations; by W. W. Coblenz and W. B. Emerson. 2d edition. Apr. 4, 1918. 26 p. 12 text fig.	1,000	459	118.77
94. Effusion method of determining gas density; by Junius David Edwards. June 20, 1917. [Reprint.] 30 p. 1 pl. 11 text fig.	500	560	32.42
96. Durability of cement drain tile and concrete in alkali soils (containing results of third year's tests); by R. J. Wig, G. M. Williams, and A. N. Finn, in cooperation with S. H. McCrory, E. C. Bebb, and L. R. Ferguson. Nov. 15, 1917. 94 p. 5 pl. 40 p. of pl.	2,500	1,998	1,217.71
97. Some unusual features in microstructure of wrought iron; by Henry B. Rawdon. Sept. 20, 1917. 25 p. 1 pl. 10 text fig.	750	780	153.60
98. Effects of heat on celluloid and similar materials [with bibliography]; by H. N. Stokes and H. C. P. Weber. Oct. 15, 1917. 40 p. 15 text fig.	750	385	184.90
99. Gas-mantle lighting conditions in 10 large cities in United States; by R. S. McBride and C. E. Reinicker. Oct. 29, 1917. 37 p.	500	500	185.20
Same [reprint].	1,000	478	49.60

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF STANDARDS—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Technologic papers—Continued.			
100. Determination of absolute viscosity by short-tube viscosimeters; by Winslow H. Herschel. Nov. 9, 1917. 65 p. 10 text fig.	1,000	663	\$302.26
102. Properties of Portland cement having high magnesia content; by E. H. Bates. Jan. 19, 1918. 42 p. 15 text fig.	1,500	219	280.14
108. Typical cases of deterioration of Munis metal (60:40 brass) by selective corrosion; by Henry S. Rawdon. Dec. 15, 1917. 28 p. 14 text fig.	1,000	463	186.06
104. Effect of size of frog in fire-bray bodies; by F. A. Kirkpatrick. Mar. 12, 1918. 39 p. 20 text fig.	500	200	219.73
105. Comparative tests of porcelain laboratory ware; by C. E. Waters. Dec. 10, 1917. 8 p.	1,000	290	34.63
106. Stabilized-platform weighing scale of novel design; by Frederick J. Schlink. Mar. 12, 1918. 23 p. 1 pl. 18 text fig.	1,000	414	148.06
107. Comparative tests of chemical glassware; by Percy H. Walker and F. W. Smith. Apr. 5, 1918. 23 p. 1 pl. 3 p. of pl. 4 text fig.	1,000	206	152.20
108. Ground connections for electrical systems [with bibliography]; by O. S. Peters. June 20, 1918. 224 p. 42 text fig.	2,500	76	1,153.30
112. Standardization of Saybolt Universal viscosimeter; by Winslow H. Herschel. June 27, 1918. 25 p. 4 text fig.	1,000	75	145.28
113. Determination of permeability of balloon fabrics; by Junius David Edwards. July 2, 1918. 31 p. 7 text fig.	1,000	78	133.71
International metric system of weights and measures. [Reprint.] 15 p. 6 text fig. 7x10".....	5,000	2,917	99.39
International aircraft standard specifications [all 8x10 1/2"]:			
Classification of international aircraft standards—Serial numbers of International Aircraft Standards Board specifications. Sept. 1917. 1 p.	1,000	1,000	5.65
101. General specifications for testing and inspection of metallic materials. Sept. 1917. 6 p. 4 text fig.	2,000	2,000	51.06
111. List of specifications. Sept. 1917. 1 p.	1,000	1,000	6.64
Same. Jan. 1918. 3 p.	1,000	1,000	13.92
2F1. Mercerized cotton airplane fabric (grade A). Apr. 1918. 3 p. 1 text fig.	1,000	1,000	14.96
2F2. Unmercerized cotton airplane fabric (grade A). Apr. 1918. 3 p. 1 text fig.	1,000	1,000	12.01
2F3. Mercerized cotton airplane fabric (grade B). Apr. 1918. 3 p. 1 text fig.	1,000	1,000	12.18
2F4. Unmercerized cotton airplane fabric (grade B). Apr. 1918. 3 p. 1 text fig.	1,000	1,000	12.01
2N1. Ingot aluminum. Oct. 1917. 1 p.	1,000	1,000	8.77
2N2. Ingot copper. Oct. 1917. 1 p.	1,000	1,000	6.97
2N3. Spelter. Oct. 1917. 2 p.	1,000	1,000	8.84
2S1. Chemical compositions of steels. Sept. 1917. 2 p.	1,000	1,000	26.06
2V1. Airplane spar varnish. Mar. 1918. 2 p.	1,000	1,000	8.76
2W1. Aircraft Douglas fir. Nov. 1917. 2 p.	1,000	1,000	11.53
2W2. Aircraft spruce. Jan. 1918. 2 p.	1,000	1,000	8.93
2W3. Mahogany lumber for use in propeller construction. Apr. 1918. 2 p. 1 text fig.	1,000	1,000	10.98
3N1. Gun-metal castings. Sept. 1917. 1 p.	1,000	1,000	6.73
3N2. Manganese bronze castings. Oct. 1917. 1 p.	1,000	1,000	6.45
3N3. Phosphor-bronze castings for bearings. Nov. 1917. 1 p.	1,000	1,000	6.45
3N4. Naval brass or equivalent alloy bars. Sept. 1917. 2 p.	1,000	1,000	11.13
3N5. Naval brass or equivalent alloy sheet. Oct. 1917. 2 p.	1,000	1,000	7.96
3N6. Soft brass sheet. Oct. 1917. 3 p.	1,000	1,000	90.75
3N7. Seamless brass tubes. Dec. 1917. 2 p.	1,000	1,000	11.92
3N8. Sheet copper. Oct. 1917. 2 p.	1,000	1,000	9.05
3N9. Phosphor-bronze strip. Oct. 1917. 3 p.	1,000	1,000	4.11
3N10. Babbitt metal for bronze-backed bearings. Dec. 1917. 1 p. 1 text fig.	1,000	1,000	10.01
3N11. Aluminum alloy castings. Oct. 1917. 2 p.	1,000	1,000	11.80
3N12. Sheet aluminum. Oct. 1917. 2 p.	1,000	1,000	14.49
3N13. Soft solder. Nov. 1917. 1 p.	1,000	1,000	5.78
3N14. Seamless copper tubes. Dec. 1917. 2 p.	1,000	1,000	14.01
3N15. Brass wire for brazing. Dec. 1917. 1 p.	500	500	5.43
3N16. Aluminum alloy sheet. Dec. 1917. 2 p.	1,000	1,000	13.88
3N17. Aluminum alloy tubing. Mar. 1918. 2 p.	1,000	1,000	8.76
3N19. Bronze castings for bearings. Mar. 1918. 2 p.	1,000	1,000	8.50
3N22. Free cutting or screw machine brass bars. Mar. 1918. 2 p.	1,000	1,000	11.95
3S1. Carbon steel bars and billets for casehardening. Sept. 1917. 2 p.	1,000	1,000	10.37
3S2. Medium carbon steel bars and billets. Sept. 1917. 2 p.	1,000	1,000	7.90
3S3. Alloy steel bars and billets (100,000 pounds per square inch tensile strength). Sept. 1917. 3 p.	1,000	1,000	21.63
3S4. Alloy steel bars and billets (125,000 pounds per square inch tensile strength). Sept. 1917. 3 p.	1,000	1,000	20.72
3S5. Alloy steel bars and billets (150,000 pounds per square inch tensile strength). Sept. 1917. 3 p.	1,000	1,000	21.74

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

BUREAU OF STANDARDS—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
International aircraft standard specifications—Continued.			
386. Alloy steel bars and billets (175,000 pounds per square inch tensile strength). Sept. 1917. 3 p.	1,000	1,000	\$23.99
387. Alloy steel bars and billets (200,000 pounds per square inch tensile strength). Sept. 1917. 2 p.	1,000	1,000	13.77
388. Alloy steel bars and billets (225,000 pounds per square inch tensile strength). Sept. 1917. 2 p.	1,000	1,000	15.72
389. Alloy steel bars and billets for casehardening (165,000 pounds per square inch tensile strength). Sept. 1917. 2 p.	1,000	1,000	12.83
3810. Alloy steel bars and billets for casehardening (180,000 pounds per square inch tensile strength). Sept. 1917. 2 p.	1,000	1,000	12.36
3811. Tolerances on steel bars, sheets, tubes, wires, and cables. Oct. 1917. 2 p.	1,000	1,000	49.33
3812. High-strength steel wire. Sept. 1917. 3 p.	1,000	1,000	26.78
3813. 19 nonflexible steel-wire cable. Oct. 1917. 4 p.	1,000	1,000	40.61
3814. 7 x 7 flexible steel-wire cable. Oct. 1917. 4 p.	1,000	1,000	38.58
3815. 7 x 19 extra-flexible steel-wire cable. Oct. 1917. 4 p.	1,000	1,000	33.33
3816. Iron or steel wire for acetylene welding. Sept. 1917. 1 p.	1,000	1,000	5.65
3817. Steel wire for electric welding. Sept. 1917. 1 p.	1,000	1,000	5.65
3818. Alloy steel bars and billets for casehardening (130,000 pounds per square inch tensile strength). Oct. 1917. 2 p.	1,000	1,000	11.84
3819. Galvanized steel service or locking wire. Dec. 1917. 2 p.	1,000	1,000	7.99
3820. Cold-rolled or drawn carbon steel bars. Nov. 1917. 2 p.	1,000	1,000	17.90
3821. Welded steel tubes. Nov. 1917. 2 p.	1,000	1,000	11.16
3822. Mild carbon steel tubes. Nov. 1917. 2 p.	1,000	1,000	10.33
3823. Medium carbon steel tubes. Nov. 1917. 2 p.	1,000	1,000	9.86
3824. Alloy steel tubes. Nov. 1917. 2 p.	1,000	1,000	18.33
3825. Extra soft carbon steel sheet. Oct. 1917. 2 p.	1,000	1,000	15.48
3826. Soft carbon steel sheet. Oct. 1917. 2 p.	1,000	1,000	14.05
3827. One-half hard carbon steel sheet. Oct. 1917. 2 p.	1,000	1,000	14.65
3828. Alloy steel sheet. Oct. 1917. 3 p.	1,000	1,000	22.27
3829. Annealed carbon steel forgings and stampings (65,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	9.94
3830. Heat-treated carbon steel forgings and stampings (80,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	9.78
3831. Heat-treated carbon steel forgings and stampings (95,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	9.78
3832. Heat-treated alloy steel forgings and stampings (100,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	10.20
3833. Heat-treated alloy steel forgings and stampings (120,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	9.94
3834. Heat-treated alloy steel forgings and stampings (130,000 pounds per square inch tensile strength). Dec. 1917. 2 p.	1,000	1,000	11.37
3835. Half-hard carbon steel bars and billets. Dec. 1917. 2 p.	1,000	1,000	9.43
3836. Cast iron. Apr. 1918. 2 p.	1,000	1,000	8.85
3837. Alloy steel seamless tubes (200,000 pounds per square inch tensile strength). Jan. 1918. 3 p. 1 text fig.	1,000	1,000	18.08
3838. Valve forgings. Jan. 1918. 2 p.	1,000	1,000	13.87
4E1. Construction of airplane propellers. Feb. 1918. 4 p.	1,000	1,000	17.72
4P1. Turnbuckles. Oct. 1917. 3 p. 1 text fig.	1,000	1,000	36.12
4P2. Aircraft ferrules and thimbles. Oct. 1917. 3 p. 3 text fig.	1,000	1,000	28.17
4P3. Plain and ball head bolts for aircraft. Nov. 1917. 3 p. 2 text fig.	1,000	1,000	23.57
4P4. Plain, ball, and castle hexagon nuts for aircraft. Dec. 1917. 3 p. 3 text fig.	1,000	1,000	32.38
4P5. Square and round bevel washers. Dec. 1917. 2 p. 2 text fig.	1,000	1,000	16.63

STEAMBOAT-INSPECTION SERVICE.

Annual report of Supervising Inspector General, 1917. 42 p.	1,000	895	\$233.08
General rules and regulations prescribed by board of supervising inspectors: Ocean and coastwise, amended Jan. 1916; further amended June 2-6, 1916. Edition Nov. 21, 1916. [Reprint.] 192 p. 8 text fig.	15,000	15,000	842.30
Same, amended Jan. 1918; further amended Mar. 15 and 16, and Apr. 3, 1918. Edition Apr. 8, 1918. 205 p. 8 text fig.	23,000	3,000	2,053.38
Lakes other than Great Lakes, bays, and sounds, amended Jan. 1916; further amended June 2-6, 1916. Edition Nov. 21, 1916. [Reprint.] 150 p. 6 text fig.	3,000	3,000	170.72
Same [reprint]....	5,000	5,000	118.99
Rivers, amended Jan. 1916; further amended June 2-6, 1916. Edition Nov. 21, 1916. [Reprint.] 144 p. 6 text fig.	5,000	5,000	257.28
Amendments of steamboat-inspection rules and regulations. Mar. 30, 1917. (Circular letter.) [Reprint.] 20 p.	5,000	2,500	35.55
Tenth supplement to General rules and regulations, edition of Nov. 21, 1916. Mar. 6, 1918. (Circular letter.) 8 p.	20,000	20,000	80.48
Same [reprint]....	2,000	2,200	10.76

PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF,
FISCAL YEAR 1918—Continued.

STEAMBOAT-INSPECTION SERVICE—Continued.

Title and description.	Re- ceived.	Dis- tributed.	Cost.
Laws governing Steamboat-Inspection Service; Revised Statutes as modified by acts of Congress. Edition July 14, 1917. 87 p.....	15,000	15,000	\$484.20
Same [reprint, with slight corrections].....	20,000	4,000	629.09
Pilot rules for certain inland waters of Atlantic and Pacific coasts and coast of Gulf of Mexico. Edition Aug. 14, 1917. 32 p. 5 text fig.....	75,000	57,000	978.47
Pilot rules for rivers whose waters flow into Gulf of Mexico and their tributaries and Red River of North. Edition Aug. 1, 1911. [Reprinted Aug. 1, 1917, with modified boundary lines of inland waters.] 22 p. 5 text fig.....	15,000	8,000	189.09
Pilot rules for Great Lakes and their connecting and tributary waters. Edition May 1, 1912. [Reprint.] 20 p. 5 text fig.....	15,000	15,000	156.86
Same [reprint].....	15,000	2,000	156.89
Description and instructions for use of smoke producing apparatus: Smoke funnel, mark 1; smoke box, mark 1. [Confidential.] (Ordnance pamphlet 540, Department of Navy.) July, 1917. 13 p. 8 text fig.....	1,500	1,425	49.23
Steamboat-Inspection Service bulletin [issued monthly, July 1, 1917-June 1, 1918, nos. 21-32, 2-6 p. each]. 35 p.....	27,400	27,400	138.02

There is listed in the foregoing table a total of 1,141 publications, compared with 1,192 for the same bureaus and offices during the fiscal year 1917, a decrease of 51. Only 13 publications were printed in two or more editions during 1918, against 36 in 1917, while 87, compared with 126 last year, were reprints without change of issues of earlier years.

The publications issued in 1918 contained a total of 42,644 printed pages, compared with 54,407 in 1917, and there were printed of them for the Department a grand total of 4,804,180 copies, against 4,444,200 in the preceding year, an increase of 359,980.

The average edition of the publications in 1918 was 4,210 copies, against 3,728 in 1917, while the average number of pages in the 1918 publications was 37, compared with 46 in 1917.

The total cost of all publications issued in 1918 was \$300,382.75, compared with \$316,013.57 in 1917.

The following recapitulation of the table, together with summary figures for 1916 and 1917, is submitted for comparative purposes:

Bureau or office.	Publications.			Pages.		
	1916	1917	1918	1916	1917	1918
Office of the Secretary.....	77	78	70	2,423	3,006	2,860
Bureau of the Census.....	836	135	83	14,165	13,161	4,626
Coast and Geodetic Survey.....	56	62	55	2,960	3,097	5,378
Bureau of Fisheries.....	81	81	91	2,620	2,440	2,852
Bureau of Foreign and Domestic Commerce.....	575	553	544	21,645	17,803	16,372
Bureau of Lighthouses.....	129	111	100	4,361	3,067	3,517
Bureau of Navigation.....	23	23	16	3,207	3,102	1,576
Bureau of Standards.....	150	122	158	8,323	6,623	4,601
Steamboat-Inspection Service.....	18	28	24	983	2,068	970
Total.....	1,945	1,192	1,141	61,702	54,407	42,644

Bureau or office.	Copies printed for Department.			Cost.*		
	1916	1917	1918	1916	1917	1918
Office of the Secretary.....	261,850	183,550	231,050	\$6,331.07	\$7,157.00	\$6,909.21
Bureau of the Census.....	1,432,910	645,150	427,875	54,283.37	92,562.23	73,150.95
Coast and Geodetic Survey.....	79,750	109,300	95,800	22,218.71	25,577.94	37,775.82
Bureau of Fisheries.....	171,350	339,700	961,840	10,330.38	11,681.49	13,634.18
Bureau of Foreign and Domestic Commerce.....	4,359,200	2,411,450	2,225,850	120,459.01	114,987.10	107,359.38
Bureau of Lighthouses.....	351,175	270,800	309,050	21,646.99	18,720.83	19,126.80
Bureau of Navigation.....	69,950	52,750	22,095	17,483.47	14,808.72	12,435.29
Bureau of Standards.....	208,050	188,300	238,950	28,209.20	21,202.22	23,154.69
Steamboat-Inspection Service.....	204,900	293,200	263,900	8,062.35	9,870.44	6,634.33
Total.....	7,124,035	4,444,200	4,804,180	289,033.53	316,013.57	300,382.75

* Figures relate to publications actually delivered to the Department during the year; consequently they do not agree with similar figures in a preceding table giving the cost of work done by the Government Printing Office during the fiscal year. Frequently the cost of a publication is charged against allotments for two or more fiscal years.

DISTRIBUTION OF PUBLICATIONS.

In explanation of the apparent discrepancy between statistics of distribution in the following statements and those of publications issued, given in a preceding table, it should be stated that a considerable proportion of the publications of the Department is printed for official use only or is distributed through the bureaus or their field offices. The statistics following relate only to distribution by the Division of Publications.

During the last fiscal year 3,863,594 publications and printed circulars of the Department were distributed to the public through the Division of Publications, compared with a total of 3,593,563 during the fiscal year 1917. Of the total number distributed in 1918, 2,802,305 were wrapped and mailed by the Superintendent of Documents and 1,061,289 by the Division of Publications. Those wrapped and mailed by the Superintendent of Documents comprised a mailing-list distribution of 2,516,649 and a distribution in response to individual requests of 285,656.

There were received and acted on during the year 61,538 miscellaneous requests, calling for 568,703 copies of publications, compared with 106,301 requests, calling for 891,971 copies in 1917. This was an average of 205 requests and 1,896 publications for each working day, against an average of 354 requests and 2,973 publications during the preceding year.

The number of publications distributed each month during the past three fiscal years is shown in the following table:

Month.	Mailed by Division.			Mailed by Superintendent of Documents.			Total.		
	1916	1917	1918	1916	1917	1918	1916	1917	1918
July.....	30,356	50,668	90,773	185,235	216,879	242,292	215,591	267,547	333,065
August.....	32,176	19,733	58,264	259,428	359,800	240,480	291,604	379,533	298,744
September.....	35,493	10,415	73,291	273,979	297,628	215,227	309,472	308,043	288,518
October.....	42,299	21,286	58,353	377,136	290,363	198,854	419,435	311,649	257,237
November.....	47,610	27,241	55,263	292,384	274,623	250,364	359,994	301,864	305,427
December.....	29,226	24,637	81,162	333,243	231,637	250,766	302,469	256,274	311,928
January.....	19,859	24,784	102,247	220,457	289,300	268,496	240,316	264,084	400,743
February.....	26,323	19,206	134,872	218,551	235,049	198,948	244,874	254,255	328,830
March.....	31,092	52,354	88,281	218,195	185,798	247,395	247,287	238,152	335,676
April.....	29,997	47,017	39,191	317,890	260,556	240,953	347,887	408,573	280,144
May.....	32,071	83,177	61,544	301,786	203,885	235,106	333,837	287,062	296,650
June.....	52,124	58,937	218,018	243,421	257,590	208,424	295,545	316,527	426,442
Total.....	408,626	439,455	1,061,289	3,239,685	3,154,108	2,802,305	3,648,311	3,593,563	3,863,594

* Includes 190,089 publications mailed by the Superintendent of Documents for the Bureau of the Census.

The distribution of publications in 1916, 1917, and 1918, by bureaus and offices of issue, is given in the following table:

Bureau or office.	Mailed by Division.			Mailed by Superintendent of Documents.			Total.		
	1916	1917	1918	1916	1917	1918	1916	1917	1918
Office of the Secretary	188,273	132,149	274,466	31,661	33,680	52,292	219,934	165,829	326,758
Bureau of the Census	.....	.....	.....	333,965	190,080	.....	.....	333,965	190,080
Coast and Geodetic Survey	5,150	4,825	4,800	43,275	26,231	32,322	48,425	31,056	37,122
Bureau of Corporations (Federal Trade Commission) ^b	.....	.....	.....	5,826	4,744	.....	5,826	4,744	.....
Bureau of Fisheries	55,466	140,979	649,750	44,431	98,809	21,268	129,897	234,788	671,057
Bureau of Foreign and Domestic Commerce	15,379	73,392	80,092	2,687,508	2,217,515	2,112,232	2,682,885	2,290,907	2,192,324
Bureau of Lighthouses	11,620	10,444	5,846	263,922	256,116	274,653	275,542	266,500	280,499
Bureau of Navigation	43,620	3,599	840	49,462	46,897	12,065	93,082	50,496	12,935
Bureau of Standards	.....	.....	.....	161,681	140,062	105,804	161,681	140,062	105,804
Steamboat Inspection Service	59,118	74,967	45,486	1,921	1,099	1,720	61,039	75,136	47,206
Total	408,626	439,455	1,061,290	3,239,685	3,154,108	2,802,305	3,648,311	3,593,583	3,868,594

^a The Bureau of the Census has charge of the distribution of its own publications. Figures for 1917 and 1918 were obtained from that Bureau.

^b Pending the complete organization of the Federal Trade Commission during 1917, its publications were distributed by courtesy through the Division of Publications.

A summary of the publications in stock and available for distribution at the close of each of the last five fiscal years, by bureaus and offices of issue, follows. The Division has no records relating to publications of the Bureau of the Census, which accounts for the absence of figures for that Bureau.

Bureau or office.	1914	1915	1916	1917	1918
Office of the Secretary	14,118	14,546	20,152	17,448	20,823
Coast and Geodetic Survey	42,178	35,673	33,714	48,366	51,166
Bureau of Fisheries	111,554	112,634	117,964	223,700	575,309
Bureau of Foreign and Domestic Commerce	43,440	48,374	60,606	87,975	114,357
Bureau of Lighthouses	23,100	21,427	23,548	22,080	43,393
Bureau of Navigation	8,243	5,674	2,812	3,267	9,546
Bureau of Standards	89,739	131,750	138,435	132,511	180,080
Steamboat Inspection Service	1,021	315	500	366	106
Total	333,391	370,968	397,733	535,683	994,730

The Department has a large and ever-increasing number of different publications of permanent interest and value, of which it is necessary to maintain a supply to meet continuing demands. Many of these are reprinted from time to time to prevent stocks thereof from becoming exhausted. As a result, the number of publications in stock increases from year to year, as shown by the foregoing statement. The unusual increase shown for 1918, however, was due to the printing in large editions of circulars issued by the Bureau of Fisheries on the uses of fish as food. Many of the circulars were received from the printer too late for distribution within the fiscal year.

SALES OF PUBLICATIONS.

Figures furnished by the Superintendent of Documents show that during the past year his office sold a total of 2,974,021 copies of reports and pamphlets of this Department, 89,808 copies through miscellaneous sales and 2,884,213 copies by annual subscriptions. These

figures show a considerable decrease as compared with the previous year, due largely to conditions brought about by the war.

The following statement gives the number of copies of miscellaneous publications sold, and receipts therefrom, for each bureau of the Department during the fiscal years 1914 to 1918. To facilitate comparisons, there have been omitted from the table statistics of sales of publications of the Bureau of Corporations, which is not now a part of the Department, having been merged into the Federal Trade Commission on March 15, 1915.

Bureau or office.	1914		1915		1916		1917		1918 *	
	Cop-ies.	Re-ceipts.	Cop-ies.	Re-ceipts.	Cop-ies.	Re-ceipts.	Cop-ies.	Re-ceipts.	Cop-ies.	Re-ceipts.
Office of the Secretary..	50	\$14.65	84	\$16.95	165	\$27.00	106	\$11.85	45	\$11.90
Bureau of the Census....	2,130	889.60	1,955	860.10	1,864	983.20	2,026	1,062.40	2,566	1,366.00
Coast and Geodetic Sur- vey	210	128.45	283	141.70	397	186.25	505	210.00	567	196.25
Bureau of Fisheries....	13,598	447.65	1,060	244.25	7,286	380.90	7,612	608.55	2,237	551.25
Bureau of Foreign and Domestic Commerce ..	16,705	5,200.50	29,671	6,127.75	63,420	12,166.62	73,745	14,420.30	58,022	10,469.20
Bureau of Lighthouses ..	35	10.70	27	5.35	169	71.50	398	69.15	220	61.40
Bureau of Navigation ..	4,793	780.65	4,606	797.45	6,014	1,445.60	7,210	1,555.90	1,468	458.90
Bureau of Standards....	3,080	328.25	5,652	1,403.55	10,424	2,465.55	31,262	5,769.96	24,552	3,763.55
Steamboat-Inspection Service.....	47	4.40	30	6.40	29	4.25	82	3.90	41	5.20
Total.....	40,648	7,804.85	43,370	9,603.50	99,768	17,733.97	122,890	23,732.60	89,808	16,972.56

* Preliminary figures.

The subscriptions to the publications of the Department for the fiscal years 1915 to 1918, and receipts therefrom, are shown in the following statement:

Bureau and publication.	1915		1916		1917		1918 *	
	Sub-scrip-tions.	Receipts.	Sub-scrip-tions.	Receipts.	Sub-scrip-tions.	Receipts.	Sub-scrip-tions.	Receipts.
Bureau of Foreign and Do- mestic Commerce:								
Commerce Reports	4,252	\$10,562.55	9,920	\$24,709.44	7,282	\$18,131.81	5,825	\$14,461.04
Quarterly Index to Com- merce Reports	32	12.80	34	11.40	.....	.....	36	4.95
Bound volumes of Com- merce Reports	161	940.50	103	618.00	111	327.60	78	463.80
Monthly Summary of the Foreign Commerce of the United States	488	723.90	496	736.55	495	741.75	553	922.30
Quarterly Statement of Imported Merchandise Entered for Consump- tion	197	147.75	130	97.05	135	101.05	80	60.00
Sailing Dates of Steam- ships	7	2.90	.....	.....	.....	.....	.....	.....
Bureau of Standards: Bulletin	195	191.50	236	234.00	305	301.50	89	87.25
Bureau of Navigation:								
Radio Service Bulletin & Supplement to List of Radio Stations of Unit- ed States	373	92.65	407	101.65	500	125.15	.....	.....
Total.....	5,705	12,674.55	11,326	26,508.09	8,828	19,728.86	6,661	16,021.04

* Preliminary figures.

† Prior to Jan. 2, 1915, termed "Daily Consular and Trade Reports."

‡ Publication discontinued with the issue of December, 1914.

§ 1,881 copies of this bulletin were distributed free during 1915 to subscribers for the Supplement to the List of Radio Stations, which publication has been discontinued. The issuance of the Radio Service Bulletin was discontinued with the March, 1917, number for the period of the war.

Coast Pilots, Inside Route Pilots, Tide Tables, and Charts are sold by the Coast and Geodetic Survey, receipts from these sales being \$20,194.19. Thus, the total receipts from sales of the publications of the Department during the year were \$53,187.78.

MAILING LISTS.

On July 1, 1918, there were in the Division 350 mailing lists, containing 285,877 names, compared with 352 lists, with 278,442 names, a year ago. During the year 24,279 names were added to the lists and 16,844 were dropped from them; also 1 new list was established and 3 were discontinued. There was, therefore, a decrease for the year of 2 lists and a net increase of 7,435 names. More than 11,000 changes of address of persons on existing mailing lists were also made.

Stencils or plates are in use for 337 lists, with 273,008 names, of which the stencils or plates for 239 lists, with 201,766 names, are preserved in the Division and those for 98 lists, with 71,242 names, are kept in the office of the Superintendent of Documents. A year ago, stenciled or embossed plates were in use for 343 lists, with 265,757 names, of which 242 lists, with 193,256 names, were in the Division, and 101 lists, with 72,501 names, were at the office of the Superintendent of Documents. For 13 lists, comprising 12,869 names, compared with 9 lists, comprising 12,685 names, a year ago, address plates have not been embossed, the lists being preserved in card form only.

EDITORIAL WORK.

The editorial force of the Division of Publications (1) reads critically all manuscripts submitted for publication, and makes such emendations or suggestions as seem necessary to secure compliance with the law and the Department's regulations and to assure the maintenance of the Department's standards; (2) supplies or revises titles, lists of contents and illustrations, indexes, abstracts, illustration legends and headlines, etc.; and (3) determines, in accordance with the law and the policies adopted thereunder by the Public Printer, the form and style of the Department's publications.

The total printing and binding expenditure during the past year was \$394,952.24, of which amount \$309,844.46 was expended for publication work. Consequently, it is in this class of work, rather than in printed forms and other small work, that the greater printing economies are effected.

DUPLICATING WORK.

The addressing and duplicating equipment was utilized not only by the various bureaus and offices of the Department, but also by other departments and independent establishments. The extent of the service rendered is apparent from the statements here presented.

The output of the machines for duplicating typewritten letters and documents for each month of the last three years was as follows:

Month.	Requisitions.			Pages duplicated.			Copies printed.		
	1916	1917	1918	1916	1917	1918	1916	1917	1918
July.....	262	275	306	597	578	663	478,376	341,760	777,302
August.....	180	367	367	647	708	806	283,460	410,015	709,545
September.....	252	228	255	701	799	528	396,272	384,067	542,840
October.....	261	318	272	785	670	612	448,415	403,287	507,361
November.....	288	287	271	685	535	603	572,623	394,267	441,885
December.....	287	320	286	612	705	611	437,675	475,951	579,941
January.....	300	330	308	763	682	574	365,155	711,794	467,908
February.....	244	265	316	623	621	614	589,666	753,689	471,264
March.....	252	317	302	560	746	625	605,186	790,705	588,488
April.....	241	278	312	822	572	661	705,751	535,809	506,793
May.....	357	384	296	909	713	535	565,620	729,646	443,365
June.....	286	320	275	680	602	584	466,682	661,685	613,789
Total.....	3,280	3,604	3,566	8,424	7,925	7,445	5,813,800	6,589,515	6,767,305

These figures represent a decrease of 38, or 1 per cent, in the number of jobs; a decrease of 480, or 6 per cent, in the number of pages; but an increase of 177,880, or 3 per cent, in the number of copies printed.

Also the mechanical equipment of the section was utilized for folding 1,717,961 letters and documents (a decrease of 17 per cent), sealing and mailing 1,567,165 envelopes (a decrease of 11 per cent), and the addressing of 3,416,850 envelopes, franks, cards, and tags (a decrease of 5 per cent).

In addition to the mechanical output, sheets inserted in envelopes (work which must be done entirely by hand) numbered 1,186,835, an increase of 7 per cent.

ADVERTISING.

During the fiscal year 1918 the Department expended \$2,494.25 for advertising for proposals for furnishing supplies of various kinds, for construction work, and for the purchase of condemned property. Records pertaining to these advertisements are maintained in the Division of Publications, which makes up the authorizations to publish and checks and approves the vouchers for payment.

The following statement shows for each of the past five years, by bureaus and offices, the number of different advertisements inserted, the number of authorities to publish issued (one authority being made up for each paper authorized to issue each advertisement), the number of insertions authorized, and the total cost of such advertisements:

Bureau or office.	Advertisements inserted.					Authorities to publish issued.				
	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918
Office of the Secretary.....	2	3	9	3	12	10	15	10	6	26
Coast and Geodetic Survey.....	11	23	11	20	23	20	93	43	72	51
Bureau of Fisheries.....	6	10	11	9	17	27	56	52	33	59
Bureau of Foreign and Domestic Commerce.....			4	3				14	11	
Bureau of Lighthouses.....	138	182	186	183	264	464	504	579	546	596
Bureau of Navigation.....			1					5		
Bureau of Standards.....	2	8	8	10	19	6	30	20	30	30
Total.....	180	226	223	237	275	526	707	732	706	786

Bureau or office.	Insertions authorized.					Total cost.				
	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918*
Office of the Secretary.....	26	44	20	18	80	\$45.20	\$88.02	\$65.85	\$31.02	\$142.22
Coast and Geodetic Survey.....	74	225	122	190	123	107.16	343.33	190.59	209.23	203.61
Bureau of Fisheries.....	64	142	135	81	119	108.17	174.62	195.80	123.94	233.52
Bureau of Foreign and Domestic Commerce.....			42	11				76.67	57.97	
Bureau of Lighthouses.....	1,226	1,636	1,606	1,408	1,527	1,678.63	2,224.74	1,930.40	1,582.73	1,794.88
Bureau of Navigation.....			20					24.30		
Bureau of Standards.....	18	96	82	108	145	34.06	217.42	101.27	185.66	120.52
Total.....	1,408	2,143	2,037	1,816	1,994	1,968.41	3,068.14	2,584.88	2,190.55	2,494.25

* Figures subject to slight revision, owing to a few estimates of cost having been made in cases where newspapers have delayed rendering bills.

The statement shows that there was an increase in 1918 in the number of advertisements inserted, the number of authorities issued, the number of insertions authorized, and the total cost. The average number of newspapers used for each advertisement was 2.86 in 1918 and 2.99 in 1917, and the average number of insertions was 2.54 in 1918 and 2.56 in 1917. The average cost for advertising in each case was \$9.07 in 1918 and \$9.24 in 1917, while the average cost per insertion of an advertisement was \$1.25 in 1918 and \$1.21 in 1917.

ESTIMATE FOR PRINTING AND BINDING, 1920.

The Division will submit an estimate of \$342,000 for printing and binding for 1920, a decrease of \$58,000 as compared with the appropriation for 1919. This decrease is due to the fact that for the fiscal year 1920 printing for the Bureau of the Census will be paid for out of the lump appropriation for the Fourteenth Census. The amount expended for printing and binding for the Bureau of the Census during 1918 was \$96,487.31. The allotment to the Department was the same for each of the years 1918 and 1919—\$400,000. Consequently, for the other bureaus, offices, and services of the Department an increase of \$38,487.31 is requested.

The total of the estimates submitted by the several bureaus and offices is \$363,600. The several amounts asked for have, however, been reviewed by the Division of Publications, with the result that reductions in the sum of \$21,600 have been made.

The accompanying table shows the expenditures for each of the fiscal years 1914 to 1918, inclusive; average expenditures for the five-year period; suballotments for 1919; and estimates (both of the bureaus and the Division of Publications) for 1920 for printing and binding for the Department of Commerce, by bureaus, offices, and services.

EXPENDITURES FOR PRINTING AND BINDING FOR THE DEPARTMENT OF COMMERCE, BY BUREAUS, OFFICES, AND SERVICES, FOR EACH OF THE FISCAL YEARS 1914-1918; AVERAGE EXPENDITURES FOR THE FIVE-YEAR PERIOD; SUBALLOTMENTS FOR 1919; AND ESTIMATES FOR 1920.

Bureau, office, or service.	Expenditures.						Sub-allocation for 1919.	Estimates, 1920.	
	1914	1915	1916	1917	1918	Average, 1914-1918.		Bureau.	Division.
Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications).....	\$12,655.94	\$19,537.58	\$16,581.71	\$15,432.08	\$18,388.96	\$16,519.25	\$17,000.00	\$17,000.00	\$17,000.00
Appointing Division.....	323.58	370.22	294.86	373.00	651.23	424.73	450.00	700.00	650.00
Disbursing Office.....	692.08	413.13	717.26	694.21	694.73	623.79	750.00	500.00	800.00
Division of Supplies.....	503.43	635.04	687.39	184.32	203.53	433.69	225.00	250.00	250.00
Bureau of the Census.....	110,733.23	122,302.92	84,794.94	115,971.35	98,437.31	108,637.35	98,000.00	(c)	(c)
Coast and Geodetic Survey.....	28,837.49	29,345.77	28,794.77	28,685.65	45,516.91	31,035.01	35,000.00	50,000.00	45,000.00
Bureau of Fisheries.....	12,687.49	13,916.77	12,460.20	16,432.45	15,314.28	14,172.14	15,000.00	17,000.00	17,000.00
Bureau of Foreign and Domestic Commerce.....	132,034.06	103,424.74	121,322.35	121,533.73	118,317.02	121,332.51	128,000.00	152,375.00	152,000.00
Bureau of Lighthouses.....	29,560.31	24,423.15	21,963.27	13,899.17	18,034.42	21,944.69	21,000.00	24,014.00	29,000.00
Lighthouse Service.....	29,560.31	24,423.15	21,963.27	13,899.17	18,034.42	21,944.69	21,000.00	24,014.00	29,000.00
Bureau of Navigation.....	12,473.34	14,183.69	16,938.50	4,771.61	12,803.23	14,243.73	14,000.00	17,000.00	17,000.00
Shipping and Radio Services.....	3,540.90	2,977.97	5,373.24	3,681.34	3,897.74	3,772.13	4,000.00	5,000.00	5,000.00
Bureau of Standards.....	28,033.31	24,376.38	35,824.68	23,934.34	36,663.74	29,604.49	30,000.00	38,000.00	38,000.00
Office of the Supervising Inspector General, Steamboat-Inspection Service.....	2,637.23	2,901.64	2,335.03	1,009.08	1,760.34	2,108.66	1,800.00	1,800.00	1,800.00
Steamboat-Inspection Service.....	2,637.23	2,901.64	2,335.03	1,009.08	1,760.34	2,108.66	1,800.00	1,800.00	1,800.00
Customs Service.....	13,351.41	9,267.49	11,166.58	6,713.76	10,060.03	10,127.37	10,000.00	12,000.00	12,000.00
Bureaus and offices separated from the Department.....	94,468.46	17,000.00					10,000.00	12,000.00	12,000.00
Reserve.....							6,275.00	8,500.00	8,500.00
Total.....	494,700.77	399,999.47	389,878.28	382,602.76	394,832.24		400,000.00	383,600.00	342,000.00
Allotment.....	525,000.00	400,000.00	390,000.00	400,000.00	400,000.00		400,000.00		

The fiscal year 1920 will be within the Fourteenth Census period, and it is assumed that the appropriation for the decennial census will provide also for permanent census printing.

Figures represent for 1915, expenditures for Bureau of Corporations (now Federal Trade Commission) and, for 1914, expenditures for that Bureau and for bureaus, offices, and services transferred to the Department of Labor.

ACKNOWLEDGMENT.

The Division of Publications desires to make acknowledgment of the splendid cooperation of the Government Printing Office in handling the Department's printing and binding during the past year, a period when the demands upon that office were so largely increased in consequence of additional and urgent printing incident to the war required by the various services of the Government.

Respectfully,

T. F. McKEON,
Chief, Division of Publications.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

97796°—COM 1918—55

INDEX.

	Page.
Aberdeen, Md., towers for ordnance test.....	121
Aberdeen, Wash., electrolysis survey.....	298
Accidents, vessels.....	10, 119, 140, 780
lives lost.....	10, 119, 140, 146, 780
Accounts section, Foreign and Domestic Commerce Bureau.....	237
Acids in explosives, census.....	452
Acids, production and capacity, manufacturing establishments.....	96
Acoustics and sound, studies.....	76, 281, 338
Adjustment, trade difficulties.....	180, 185
Admeasurement of vessels.....	149, 816
Admiral Evans, vessel stranded.....	650
Admiral Farragut, vessel stranded.....	650
Advertising, proposals for materials and supplies.....	43, 862
Aerodynamics, investigations.....	261
Aeronautic instruments, studies.....	359
Aeronautical research.....	68
Aeroplane fabric, Standards Bureau experiments.....	169
Africa, disputed areas, Census Bureau data.....	459
Agas, pensioners', records.....	100
registrants, transcripts.....	98
Agricultural implements, foreign markets.....	191
Agriculture Department, cooperation of Commerce Department.....	60, 106, 221, 229, 252, 256, 285, 331, 340, 378, 407, 460, 487, 496, 492
Aids to navigation, Alaska.....	114, 569, 571, 606, 625, 628, 635
appropriations and expenditures.....	21, 22, 26
bridges lighted.....	593
Caribbean Sea, national security and defense fund.....	31, 630
classified list.....	587
completed.....	632
fog signals.....	589, 593
gas buoys established and discontinued.....	592
Hawaii.....	607, 628, 629
improvement of apparatus and equipment.....	115, 120
light vessels, discontinued.....	593
in commission.....	594
lights, characteristics.....	588
discontinued.....	591
established.....	590
illuminants, details.....	588
improved.....	591
on vessels.....	589
maintained under contract.....	593
Navassa Island, West Indies, light station established.....	112, 115, 593, 596, 599, 633
number.....	114
Potomac River, funds needed.....	120
private aids maintained.....	593
Virgin Islands, West Indies.....	570, 623
Airplane dopes.....	349
Airplane-engine laboratory, Standards Bureau.....	14
Airplane materials, investigations.....	363
Airplane power plants, research work.....	70, 312
Airplanes, studies.....	68, 69, 70
Alaska, aids to navigation.....	114, 569, 571, 606, 625, 628, 635
Anklet, Fisheries Bureau vessel.....	550
beaver, extending close season.....	557
Dutch Harbor, purchase recommended.....	46
fisheries.....	109, 547

	Page.
Alaska, fishery, exploitation.....	551
Intelligence service.....	551
patrol and stream watchmen.....	550
permits, Aleutian Islands.....	552
violations, prosecutions.....	550
fur-bearing animals, minor protection, regulations.....	111
fur farming.....	557
fur seals.....	109, 110, 553
furs shipped.....	557
hydrography and topography.....	688
Ketchikan, lighthouse depot.....	118
light stations, estimates.....	631
magnetic work, Coast and Geodetic Survey.....	741
Murre, Fisheries Bureau vessel.....	550
Osprey, Fisheries Bureau vessel.....	550
salmon, canneries, Yukon River hatcheries, private, inspection.....	552
red, census.....	548
seal and salmon fisheries, expenditures.....	551
seal herd, census.....	23, 25, 29
Swan, Fisheries Bureau vessel.....	556
tax on salmon canned.....	550
Solicitor's opinion.....	547
vessels stranded.....	548
waters closed to commercial fishing.....	650
wire-drag operations.....	548
Alaska Packers Association, assistance, fishery census.....	125, 127, 130, 646, 658, 741
Alaska-Portland Packers' Association, assistance, fishery census.....	551
Alaskan Engineering Commission, cooperation of Department.....	551
Alaskan waters, surveys needed.....	690
Albatross, Fisheries Bureau vessel, service in Navy.....	649
Aleutian Islands, fishery permits.....	104, 558
Alewives, increasing consumption.....	552
Alleghany County, Md., mine scales, Standards Bureau tests.....	497
Alleged disloyalty, Steamboat-Inspection Service investigations.....	263
Allied tonnage losses, 1917 and 1918.....	786
Allocation of military enlistments.....	806
Allotment, Government departments, Standards Bureau.....	98
national security and defense fund, Fisheries Bureau.....	432
Foreign and Domestic Commerce Bureau.....	473
Lighthouse Service.....	230
Standards Bureau.....	580, 630
notes issued to seamen.....	431, 432
Alloys and metals, research work.....	808
Altimeters, tests.....	31, 411
Aluminum alloys.....	69
Aluminum Company of America, cooperation of Department.....	411
Amaranth, lighthouse tender.....	412
American Association of Refrigeration, cooperation of Department.....	581
American-Canadian Fisheries Conference.....	306
American Ceramic Society, cooperation of Department.....	9, 560
American Chemical Society, committee report.....	423
cooperation in census of chemical imports.....	167

	Page.		Page.
American Gas Institute, cooperation of Department.....	289	Artificial Daylighting Co., cooperation of Department.....	331
American Institute of Architects, cooperation of Department.....	289	Ashtabula Harbor, Ohio, aids to navigation.....	570, 599, 634
American Lithographic Co., cooperation of Department.....	331	Assay Office, New York, cooperation of Department.....	348
American merchant marine, tonnage.....	792	Assistant to Secretary of Commerce, position needed.....	16
American National Red Cross, cooperation of Department.....	98, 104, 284, 455, 456	Associated Factory Mutual Fire Insurance Companies, cooperation of Department.....	399
American Railway Association, cooperation of Department.....	256	Association of Edison Illuminating Companies, cooperation of Department.....	291
American shipbuilding progress.....	795	Association of State Geologists, cooperation of Department.....	424
American Shipmasters' Association, petition for light and fog signal, Anacapa Island, Cal.....	628	Aster, lighthouse tender, bids.....	598
American Society for Testing Materials, cooperation of Department.....	274, 352, 353, 369, 394, 409, 410, 417, 423	Atchafalaya Entrance Channel, La., aids to navigation.....	602
American Society of Civil Engineers, cooperation of Department.....	370	Atlantic coast, aids to navigation.....	571, 601
American Society of Mechanical Engineers, cooperation of Department.....	262, 366	hydrographic and topographic work.....	684, 706
American Society of Refrigerating Engineers, cooperation of Department.....	306	wire-drag operations.....	121, 125, 130, 646, 647, 658, 706
American Steamship Association, cooperation of Department.....	444	Atlantic intracoastal waterways, development.....	47
American Writing Paper Co., cooperation of Department.....	331	Auklet, Fisheries Bureau vessel.....	477
Anacapa Island, Cal., light station, estimate.....	628	Australian customs authorities, cooperation of Department.....	403
Analytical methods, Standards Bureau.....	355	Australian, West, Government, cooperation of Department.....	670, 695
Anderson, Norman L., foreign-trade investigations.....	199, 202	Bache, Coast and Geodetic Survey vessel, operations.....	644, 680, 684, 711, 712
Antismarial campaigns, Fisheries Bureau.....	489	Bacteriology of preserved fish.....	485
Appointments. <i>See</i> Personnel.....		Balance of trade.....	50
Appropriations and expenditures.....	16	Balfour, Lord, Committee on Commercial and Industrial Policy After the War.....	222
Census Bureau.....	17, 20, 25, 27, 28, 466	Barrett, Robert S., foreign-trade investigations.....	193, 202
Coast and Geodetic Survey.....	17, 23, 25, 27, 28, 667, 683, 706	Beaufort, N. C., Fisheries Bureau station transferred to Navy.....	104, 494
commercial attachés.....	17, 23, 24, 28	Beaver, extending Alaska season.....	557
comparison with estimates for 1920.....	30	Bering River, Alaska, closed to commercial fishing.....	549
disbursed by authorized disbursing officers.....	17	Berkshire trout hatchery, property title.....	476
disbursed on warrants on Treasurer of United States.....	23, 27	Binding. <i>See</i> Printing and binding.....	
Fisheries Bureau.....	17, 20, 23, 25, 27, 29, 473	Birth statistics, Census Bureau reports.....	446
Foreign and Domestic Commerce Bureau.....	17, 23, 24, 27, 28, 238, 240	Bituminous materials, Standards Bureau studies.....	352
increase of compensation.....	17, 21, 22, 23	Block Island, R. I., fish-hatchery plans.....	558
Lighthouses Bureau.....	17, 21, 22, 26, 27, 29, 566, 569, 577, 598, 615	Blue Wing, Fisheries Bureau vessel, condemned and sold.....	10, 559
depots.....	579	Bonded employees.....	829
needs.....	570	Bonds, examined.....	48
special works.....	114, 118, 119, 120, 578	Liberty Loan, subscriptions.....	45, 46, 455, 456, 554, 574
tenders.....	581, 598	Books donated by employees to Library of Congress.....	44
national security and defense fund.....	13, 17, 19, 31, 32, 33, 34, 230, 238, 431, 432, 473, 580, 630	Boston, Mass., fisheries.....	504
Navigation Bureau.....	17, 19, 20, 24, 25, 27, 28	radio school.....	811
printing and binding.....	17, 39, 40, 837	Bosworth, Clarence E., foreign-trade investigations.....	193
sal and salmon fisheries, Alaska.....	20, 23, 25, 29	Bozeman, Mont., fishery station.....	558
Secretary's Office.....	17, 24, 27	Branch offices, Foreign and Domestic Commerce Bureau. <i>See</i> District offices.....	
Standards Bureau.....	17, 18, 19, 24, 27, 28, 268, 355, 431, 432	Brass investigations.....	414
Steamboat-Inspection Service.....	17, 19, 25, 27, 28, 770	Brest-Litovsk treaty, analysis.....	222
summary.....	17, 27	Bridgeport, Conn., branch gauge laboratory established.....	73
unexpended balances.....	27	Bridges lighted.....	563
Aquatic foods, increasing consumption.....	495	British Imperial Munitions Board, cooperation of Department.....	417
Aquatic products, investigations and experiments.....	484	British tonnage losses, 1917 and 1918.....	806
Aransas Pass, Tex., light station repairs.....	602	Brook, Herman G., foreign-trade investigations.....	194, 203
Arbitration Board, New York Harbor Wage Adjustment, Commissioner of Lighthouses, Department's representative.....	117	Brown, Nelson C., foreign-trade investigations.....	197, 203
cooperation of Department.....	98, 455	Building, archives, for Department's records.....	15
Arbutus, lighthouse tender.....	581	Standards Bureau, national security and defense fund.....	19
Archives building for Department's records.....	15	Buildings, additional, for decennial census work.....	14, 16, 102
Areas, disputed, Europe and Africa, tabulation of data.....	100	airplane-engine laboratory, Standards Bureau.....	14
Army, Census Bureau employees.....	99, 455	allotments from national security and defense fund.....	13, 19, 33, 34, 111
Coast and Geodetic Survey employees.....	121, 123, 138, 680	Cost and Geodetic Survey needs.....	12
Coast and Geodetic Survey officers transferred.....	663, 664	Fisheries Bureau needs.....	13
former employees in.....	39, 833	Foreign and Domestic Commerce Bureau needs.....	12
Lighthouse Service employees.....	573	Government-owned, for Department.....	11, 16
Navigation Bureau employees.....	147, 809, 817	laboratories, Fisheries Bureau.....	13, 16, 108
nonregistrants' ages, Census Bureau searches.....	458	occupied by Department.....	11
Arnold, Julean, International Customs Conference, Shanghai.....	53		

	Page.
Buildings, power plant, Standards Bureau	16
radio laboratory, Standards Bureau	14
sealing industry, by-products plant, national security and defense fund	112
Standards Bureau needs	13
Buoys. <i>See</i> Aids to navigation.	
Business methods, Steamboat-Inspection Service	783
Cacao production, investigation	214
California, aids to navigation	626
California waters, additional surveys needed	650
Camellia, lighthouse tender	681
Canada, fish eggs, shipments	479
Canadian Fisheries Conference. <i>See</i> American-Canadian Fisheries Conference.	
Canadian geodetic surveys, cooperation of Department	703
Canal Zone, fish shipments	479
Canals, Delaware and Raritan and the Cape Cod, operation by Government	47
Capacity and density, Standards Bureau studies	260
Cape Charles City, Va., aids to navigation	601
Cape Cod Canal, Mass., aids to navigation	570,
	599, 632
operation by Government	47
Cape Kumukahi, Hawaii, light, estimate	629
Cape Spencer, Alaska, light station	628
Cape Vincent, N. Y., fishery station	658
Caribbean Sea, aids to navigation, estimate	630
national security and defense fund	31, 630
Carnegie Institution of Washington, cooperation of Department	704, 705
Carp, increasing consumption	498
South Carolina, investigation of supply	488
Casualties and violations of law, Steamboat-Inspection Service	779
Catalogues, foreign, indexed file	213
Cattle raising, foreign, investigation	214
Causes of death, international list	447
Cedar, Lighthouses Bureau vessel, operations	10, 570
Cement, tests	83, 350, 372
Census Bureau, acids, production and capacity, manufacturing establishments	96
acids and materials in explosives, census	452
ages, pensioners', records	100, 458
registrants, transcripts	97
appropriations and expenditures	17,
	20, 25, 27, 28, 406
Army nonregistrants, age searches	458
buildings for decennial census work	14, 16, 102
causes of death, international list	447
chemical imports, census	167
cities, statistics	92, 447
clearing house for statistical information	95
coal consumed, data compiled for Fuel Administration	98, 445
commercial greenhouses, census	95, 452
cooperation, Agricultural Department	460
American Steamship Association	444
Commercial Economy Board	95, 451
Council of National Defense	95, 451, 452
Customs Service	444
Emergency Fleet Corporation	455
Federal Reserve Board	96, 453, 465
Federal Trade Commission	455
Food Administration	94, 451, 455
Fuel Administration	455
Housing Committee	455
Interior Department	98, 455
Joint Information Board on Minerals and Derivatives	455
Justice Department	444
National Committee on Prisons and Prison Labor	455
National Tanners' Council	455
New York Harbor Wage Adjustment Board of Arbitration	455
Port Facilities Commission	455
Post Office Department	444
Railroad Wage Commission	455
Red Cross	455
Shipping Board	94, 451, 455
Treasury Department	455
War Department	94, 96, 446, 451, 453, 454, 455
War Industries Board	94, 451, 452, 455
War Trade Board	94, 451

	Page.
Census Bureau, cotton and cotton seed	93, 449
deaf-mutes, report	94, 450
dental gold, production	96, 453
dependent, defective, and delinquent classes, report	100
disputed areas, Europe and Africa, data	100, 459
drainage-inquiry conference	460
electrical industries, 1917	91, 444
employees, in Army and Navy	99, 455
enlistments, military, allocation	98, 454
estimates of appropriations, 1920	31
exhibit, Southern Commercial Congress	762
fisheries statistics, New York City	458
fishing vessels, census	444
Fourteenth Census, buildings	14, 16, 102
estimate of appropriation	31
legislation	15, 101
preparations	100, 459
tabulating equipment	102
health index, weekly	447
"integrating counter," tabulating device	102, 463
irrigation census	460
Liberty Loan Bond Club	455, 456
"life tables," mortality conditions	100, 457
manufactures, reports	90, 443
marriage and divorce, statistics	99, 456
mechanical equipment	101
mechanical-laboratory work	101, 462
military and naval services, deferred classifications	99
employees enlisted and drafted	99,
	455, 573, 663, 664, 680, 817, 833
national security and defense fund, allotment	31
Negroes, report	94, 450
nitric acid, census	452
occupations of registrants, classification	96
office room and storage space	465
Official Register of United States	94
discontinuance recommended	46, 451
personnel	102, 464
printing and binding cost	838
prisoners and juvenile delinquents	94, 451
publications	450, 461, 843
receipts, miscellaneous	47
Red Cross subscriptions	456
registrants, ages	97, 454
estimates	97, 453
occupations	454
religious bodies	94, 445
shipbuilding census	91, 444
special statistics, national security and defense fund	31
State institutions, statistical directory	100, 458
States, financial statistics	93, 449
summary of work accomplished	90, 443
thrift stamps, sales	456
tobacco, leaf	93, 450
transportation by water	90, 444
travel expenses	9
unexpended balances	27, 28
Virgin Islands census	99, 457
vital statistics	91, 446
wages, railroad employees	98
war materials and commodities, census	451
war-savings stamps, sales	456
war work	446, 451, 455
Centennial, vessel rescued by Fisheries Bureau	559
Central and South America, expenditures in promoting commerce	17, 23, 24, 26
Ceramics division, Standards Bureau	422
Certificates, lifeboat men, efficiency	777
seamen, issued and rejected	140, 777
Chamberlain, Eugene Tyler, Commissioner of Navigation, annual report	791
Changes in Department's personnel	824
Charleston, S. C., lighthouse depot	581, 625
Charts division, Coast and Geodetic Survey	670
Charts, tide tables, coast pilots, and inside route pilots, sales	27, 42
Cheltenham, Md., magnetic observatory	648,
	705, 738
Chemical imports, census	51, 167
Chemical reagents and apparatus	347
Chemistry divisions, Standards Bureau	340
Chemistry tests	85
Cherington, Paul P., export-methods study	199

	Page.		Page.
Chesapeake Bay, Md. and Va., aids to navigation.....	601	Coast and Geodetic Survey, Oregon, surveys needed.....	650
Chicago Harbor Light Station, Ill.....	571, 605	Pacific Steamship Co., vessels stranded.....	650
China, commercial map.....	188	personnel, military services.....	121, 138, 680
investment opportunities.....	197	needs.....	131, 132, 133, 134, 135, 674
Cities, statistics.....	92, 447	statistics.....	667
Civil Service Commission, Department's requisitions.....	832	precise levels, needed.....	669
Civil-service methods, Department's.....	832	run.....	127, 648
Clay products.....	422	printing and binding cost.....	838
Clements, J. Morgan, foreign-trade investigations.....	198, 200, 203	publications.....	670, 671, 681, 694, 695, 844
Clerical needs, Coast and Geodetic Survey.....	677	receipts, miscellaneous.....	27, 668
Clerks. <i>See</i> Personnel.....		retirement, commissioned officers.....	661
Cleveland, Ohio, aids to navigation.....	570, 599, 634	employees.....	135, 678
branch gauge laboratory established.....	72	sales of publications and charts.....	27, 42, 688
natural-gas investigation.....	288	San Antonio observatory.....	671
Coal, consumed.....	98, 455	seagoing vessels, additional needs.....	15
inspection.....	45	seamen, enlistments and wages.....	130, 131, 659
Coast and Geodetic Survey, Aberdeen, Md., towers for ordnance test.....	121	subsistence allowance.....	831
aids given schooner Emma F. Potter.....	708	Tahoma, revenue cutter, lost.....	663
Alaskan surveys needed.....	649	Taku, vessel condemned and sold.....	663
appropriations and expenditures.....	17	terrestrial magnetism division, activities.....	671, 704
23, 25, 27, 28, 667, 683, 706		tidal observations.....	126, 647
buildings, national security and defense fund.....	13	tide tables, preparation and production.....	122
need of suitable.....	11, 12, 13	tides and currents section.....	694
occupied.....	11	topographic maps needed.....	697
California, surveys needed.....	650	topography.....	647
charts division, activities.....	670	travel expenses.....	9
clerical needs.....	677	triangulation work.....	127, 648
coast-pilot work.....	122, 693	unexpended balances.....	28
computers needed.....	675	vessels.....	10, 15
cooperation, Alaskan Engineering Commission.....	690	123, 124, 127, 128, 644, 649, 654, 680, 684, 711, 712	
Carnegie Institution of Washington.....	704, 705	area surveyed, Pacific coast and Alaska.....	654
Cramp Ship Building Co.....	703, 764	condemned and sold.....	123, 683
Interior Department.....	121	loaned by Philippine Government.....	10
Italian Government.....	670, 695	returned to Philippine Government.....	123, 645, 691
Lighthouse Service.....	565	transferred to Navy.....	123, 644, 680, 684, 685
Mississippi River Commission.....	688	urgent needs.....	15, 124, 649
National Advisory Committee for Aeronautics.....	122	vessels and equipment section.....	693
Navy Department.....	121	war activities.....	121, 680
122, 676, 682, 684, 695, 708, 711, 712, 750, 764		Washington office, needs.....	674
Railroad Administration.....	122	summary of work.....	666
Shipping Board.....	122	Washington, surveys needed.....	650
Standards Bureau.....	122	wire drag, launches, Alaska.....	646
Steamboat-Inspection Service.....	719		742, 743, 744, 745, 748
War Department.....	121	Atlantic coast.....	125
122, 676, 682, 696, 700, 701, 703, 718		done and to be done.....	658
West Australian Government.....	670, 695	Coast pilot distribution, 1911-1918.....	694
York River Ship Building Corporation.....	712	Coast pilot work.....	122, 693
cooperation on Canadian surveys.....	703	Coast pilots, inside route pilots, tide tables, bles, and charts, sales.....	27, 42
currents, observations.....	126, 647	Coastal fisheries, New York and New Jersey.....	532
draftsmen needed.....	674	Coconut industry, investigation.....	214
employees, commissioned in Army and Navy.....	121, 138, 680	Cod fishery.....	525
in Army and Navy.....	121, 123, 680	Coke oven, Roberts's by-product, national security and defense fund.....	19, 432
estimate of appropriations, 1920.....	33	Collisions of vessels, lighthouse property damage.....	614
exhibit, Manila carnival.....	692	Colombia, transportation in.....	214
National Motor Boat Show.....	688, 711, 763	Colombian platinum, foreign markets.....	214
Southern Commercial Congress.....	688, 711, 762	Color-blindness examinations, Steamboat-Inspection Service.....	777
field-records section.....	693	Colorimetry, studies.....	326
field-service needs.....	649	Commerce and Navigation, publication, fiscal to calendar year.....	228
field work.....	122, 663, 708	Commerce Building, Government-owned.....	11, 16
geodesy.....	127, 648, 668, 696, 700	lease.....	12
geodetic work, appropriation needed.....	669	needs of Department.....	11, 12
summary.....	703	new plans necessary.....	12
hydrographic and geodetic engineers needed.....	664	rental.....	11
hydrographic and topographic work, Alaska.....	688	Commerce, foreign. <i>See</i> Foreign and Domestic Commerce Bureau.....	
Atlantic coast.....	684, 706	Commerce Reports, contributions of foreign tariffs division.....	223
Pacific coast.....	688, 719	publication.....	63
Philippine Islands.....	690	statistical compilations.....	226
hydrography and topography division, activities.....	669, 684	Commercial agents. <i>See</i> Trade commissioners.....	
hydrography, ship and launch.....	123, 127, 644	Commercial and economic conditions, Scandinavia.....	190
instrument makers, personnel needs.....	135, 678	Commercial and Industrial Policy After the War, Lord Balfour Committee, report.....	222
launches, wire-drag.....	15		
130, 708, 709, 710, 714, 715, 742, 743, 744, 745, 748			
legislation, recent.....	137, 682		
magnetic observations.....	127, 648, 704, 738		
magnetic observatories.....	127, 648, 671, 705, 738		
national security and defense fund.....	13, 17, 23, 34		
new buildings, needs.....	679		
office force, increase.....	15		
officers transferred to Army and Navy.....	663		

	Page.		Page.
Commercial attachés, appropriations and expenditures.....	17, 23, 24, 28	Denver, Colo., Reclamation Service, transferred to Standards Bureau.....	373
changes in personnel.....	52, 170, 188	Departments, Government, allotment to Standards Bureau.....	432
clerks, increase.....	15	Dependent, defective, and delinquent classes, report.....	100
insufficient salaries.....	65	Depot keepers' dwellings, estimate.....	637
duties.....	176, 178	Depots, Lighthouse Service, construction and repair.....	571, 573, 579, 586, 599
increase.....	15, 53, 63, 182	Detroit, Mich., Lighthouse depot.....	579
insufficient appropriations.....	65, 183	Detroit River, Mich., aids to navigation.....	571, 604
special work for other departments.....	52, 184	Diamond Shoal Light Vessel No. 71, N. C., sunk.....	10, 119
summary of activities.....	40, 52, 178	Disbursements. <i>See</i> Appropriations and expenditures.	
war work.....	95, 451	Dispatch section, Standards Bureau.....	439
Commercial Economy Board, cooperation of Department.....	331	Dispersals, studies.....	338
Commercial interests, cooperation of Department.....	188	Disputed areas, Europe and Africa, data.....	100, 459
Commercial map, China.....	52	Distribution section, Foreign and Domestic Commerce Bureau.....	239
Commercial plots, German.....	117	District of Columbia, Standards Bureau tests.....	253, 375, 394, 407
Commissioner of Lighthouses, Department's representative on New York Harbor Wage Adjustment Board.....	172	District offices, aid in licensing exports.....	61
Committee on Raw Materials, Russian platinum transferred from Department.....	830	cooperation in war work.....	61, 207
Comptroller of the Treasury, decisions affecting personnel.....	675	foreign-trade activities.....	62
Computers, Coast and Geodetic Survey needs.....	372, 378	headquarters for commercial visitors.....	61
Concrete, studies.....	45	needs.....	64, 211
Condemned property, sales.....	9	samples, exhibit.....	61
Conference, American-Canadian Fisheries.....	262, 267, 342	summary of work.....	61, 210
Conferences, Standards Bureau.....	571, 604	trade-mark information.....	60
Conneaut Harbor, Ohio, aids to navigation.....	598	trading-with-the-enemy act, activities.....	61
Construction, lighthouse tenders and vessels.....	195	traveling commercial agents needed.....	64
Construction materials and machinery, foreign markets.....	509, 637	Division of foreign tariffs, Foreign and Domestic Commerce Bureau.....	221
Construction work, Lighthouse Service.....	47	Divorce, statistics.....	99, 456
Contracts examined.....	9	Dog Island, Eastport, Me., light construction.....	599
Conventions and meetings, travel expenses.....	213	Dorsey, Vernon M., cooperation of Department.....	331
Conventions, trade association.....	328, 331	Draft age, employees of Department.....	39, 633
Cooper Hewitt Electric Co., cooperation of Department.....	211	Draft, military, exemptions.....	39
Cooperative offices, Foreign and Domestic Commerce Bureau, additional needs.....	549	Draftsmen, Coast and Geodetic Survey needs.....	674
Copper River, Alaska, closed to commercial fishing.....	439	Drainage, Census Bureau conference.....	460
Copying section, Standards Bureau.....	606	Drumfish, increasing consumption.....	499
Coquille River, Oreg., aids to navigation.....	331	Dry dock, Tompkinsville, N. Y., estimate.....	580
Corning Glass Works, cooperation of Department.....	574	Du Pont de Nemours Co., E. I., cooperation of Department.....	331
Cost-keeping system and results, Lighthouse Service.....	93, 449	Duluth, Minn., electrolysis survey.....	298
Cotton and cotton seed, reports.....	192, 194	Duplicating work, Publications Division.....	861
Cotton goods, foreign markets.....	329	Dutch Harbor, Alaska, purchase recommended.....	46
Cotton Products Analysts Society, cooperation of Department.....	53, 54, 95, 97, 98, 219, 222, 402, 407, 451, 452, 454	Dyes, Standards Bureau tests.....	349
Council of National Defense, cooperation of Department.....	703, 764	Dyestuffs Convention, New York, cooperation of Department.....	329
Cramp Ship Building Co., cooperation of Department.....	581	Dyestuffs, census of chemical imports.....	51
Crocus, lighthouse tender.....	10, 119, 582	vegetable, foreign markets.....	214
Cross Rip Light Vessel No. 6, Mass., lost.....	126, 647		
Curlow, Fisheries Bureau vessel, condemned and sold.....	526	East Point Vieques Island, or Port Real, P. R., light station.....	629
Currents, observations.....	811, 814	East River, N. Y., aids to navigation.....	571, 600
Cusk fishery.....	253, 324, 325, 444	Eastland disaster, delayed prosecution.....	11
Customs officers, navigation laws enforcement.....	230	"Economic Reconstruction," publication.....	221
Customs Service, cooperation of Department.....	838	Economies, Administrative Methods, Lighthouse Service.....	573
national security and defense fund, allotment.....	155	Editorial division, Foreign and Domestic Commerce Bureau, summary of work.....	62, 234
printing and binding for, cost.....	582	Editorial work, Publications Division.....	361
Cutler, Burwell S., Chief, Foreign and Domestic Commerce Bureau, annual report.....	631	Eighth lighthouse district, depot, estimate.....	624
Cypress, lighthouse tender.....	94, 450	vessel, estimate.....	621
	446	Elmer & Amend, cooperation of Department.....	331
	830	Electrical goods, foreign markets.....	192
War Risk Insurance Bureau.....	573	Electrical industries, 1917 census.....	91, 444
Deeds examined.....	48	Electricity, division of Standards Bureau, activities.....	77, 272
Deferred classifications.....	39, 99, 833	measuring instruments.....	373
Delaware and Raritan Canal, operation by Government.....	47	safety code.....	292
Delaware Bay Entrance, aids to navigation.....	626	service standards.....	291
Delaware River, Pa. and Del., aids to navigation.....	571, 601	Electrochemistry.....	282, 341
Dental gold, production.....	96, 453	Electrolysis, prevention.....	296
		survey, Aberdeen, Wash.....	298
		Duluth, Minn.....	298
		Hoonah, Wash.....	298
		Los Angeles, Cal.....	298
		Marion, Ohio.....	298
		Milwaukee, Wis.....	298
		New Orleans, La.....	298
		Omaha, Nebr.....	298
		St. Paul, Minn.....	298
		Springfield, Mass.....	298
		Eligibles, civil-service requisitions.....	832

	Page.		Page.
Emergency Fleet Corporation, cooperation of Department.....	98, 314, 332, 371, 376, 380, 384, 407, 408, 414, 421, 455	Field-records section, hydrography and topography division, Coast and Geodetic Survey.....	698
Emma F. Potter, schooner, Coast and Geodetic Survey aid.....	709	Field-service needs, Coast and Geodetic Survey.....	649
Employees. <i>See</i> Personnel.		Field work, geodetic.....	700
Employees' Compensation Commission, cooperation of Department.....	295	Field-work section, hydrography and topography division, Coast and Geodetic Survey.....	693
Employment Service, United States, appointments through.....	832	Fifth Lighthouse district, depot, estimate.....	622
Engineering, Lighthouse Service work.....	570	tender, estimate.....	621
research and testing, Standards Bureau.....	356, 358	Fighting Island Channel, Detroit River, Mich., aids to navigation.....	604
Enlistments, military, allocation.....	98, 454	Financial statistics, cities.....	92
seamen.....	130, 131, 650	States.....	93
Estimates, appropriations, 1920.....	29, 34, 883	Fines, navigation, receipts.....	27, 147
Foreign and Domestic Commerce Bureau.....	31, 240	Fire-extinguisher investigations.....	356
Fourteenth Census.....	31	Fire-resistive properties, structural materials.....	308
geodetic, appropriation needed.....	609	Fire Underwriters, National Board, cooperation of Department.....	309
Lighthouse Service.....	30, 577, 617	First District Public-Service Commission, New York, cooperation of Department.....	288
Honolulu depot.....	579	Fish and eggs, distribution, by species.....	475
special works.....	578, 618, 621	through State commissions.....	478
printing and binding.....	34, 863	shipments to Canada, Japan, Mexico, and Canal Zone.....	479
Europe, disputed areas, Census Bureau data.....	459	Fish bones, time required to soften.....	508
Everley, Harold E., foreign-trade investigations.....	196	Fish hatcheries.....	104, 476, 488, 558
Ewing, W. W., foreign-trade investigations.....	195	appropriations and expenditures.....	20
Examinations and appointments, Foreign and Domestic Commerce Bureau.....	288	Block Island, R. I.....	558
Examinations for special registers.....	832	San Marcos, Tex.....	476
Executive orders affecting Lighthouse Service.....	573	Woods Hole, Mass.....	558
Exemptions from military duty.....	39	Fish Hawk, Fisheries Bureau vessel, service in Navy.....	104, 559
Exhibits, Coast and Geodetic Survey.....	668, 692, 711, 762, 763	Fish, home canning.....	501
Manila carnival.....	692	Fish roe and buckroe, increasing consumption.....	496
National Motor Boat Show.....	688, 711, 763	Fish waste and waste fish, utilization.....	500
New York, foreign samples.....	212	Fisheries, American-Canadian conference.....	9, 560
Southern Commercial Congress.....	688, 711, 762	Lakes Pepin and Keokuk.....	543
Expenditures, Coast and Geodetic Survey.....	687, 706	New York City, Census Bureau statistics.....	548
Census Bureau.....	466	Seattle, Wash.....	527
Lighthouse Service.....	570, 577, 598, 616	hearings.....	552
reimbursement by War Department.....	579	Fisheries Bureau, acclimatization work.....	491
Navigation Bureau.....	19, 24, 28	Alaska fisheries.....	109, 547
printing and binding.....	837, 838, 864	Albatross, vessel, service in Navy.....	104, 558
Standards Bureau.....	432	antimalarial campaigns.....	490
Steamboat-Inspection Service.....	770	appropriations and expenditures.....	17, 20, 23, 25, 27, 29, 473
<i>See also</i> Appropriations and expenditures.		aquatic products, investigations.....	494
Expenses, travel.....	9	Beaufort, N. C., station transferred to Navy.....	104, 494
Explorer, Coast and Geodetic Survey vessel, operations.....	644, 680, 689, 690, 721, 745	Blue Wing, vessel, condemned and sold.....	10
Explosives, acids and materials in, census.....	452	building, need of suitable.....	13
Export classification, revision.....	230	buildings occupied.....	11
Export control, national security and defense fund.....	17	Woods Hole, Mass., used by Red Cross and Y. M. C. A.....	104
Export licenses issued.....	207	carp, increasing consumption.....	496
Export marketing methods.....	198	supply, South Carolina.....	468
Export trade, analyses.....	160, 162	cooperation, Agricultural Department.....	106, 487, 489, 492
gold.....	158	Food Administration.....	106, 471, 473, 487
merchandise.....	156, 162	Forest Products Laboratory.....	482
Exporters' Index.....	233, 239	Forestry School, New York.....	493
Exports and Imports, balance of trade.....	50	Fuel Administration.....	471
national security and defense fund.....	17	Interior Department.....	552
Exports Control Committee, cooperation of Department.....	61	Justice Department, Alaska.....	552
Fabrics, production, national security and defense fund.....	19, 432	Lighthouse Service.....	545
Fairport Harbor, Ohio, aids to navigation.....	604	Navy Department.....	471
Fairport, Iowa, fish-cultural work.....	488, 494	Shipping Board.....	471
fisheries-laboratory fire.....	494	Standards Bureau.....	504
mussel propagation.....	483	State fishery authorities.....	473, 479
Far-eastern division, Foreign and Domestic Commerce Bureau.....	60, 220	Treasury Department.....	489
Farris, R. L., Acting Superintendent, Coast and Geodetic Survey, annual report.....	643	War Department.....	471
Fathomer, Coast and Geodetic Survey vessel, operations.....	644, 691, 750, 754	War Trade Board.....	471
Federal Board for Vocational Education, cooperation in foreign-trade education.....	175	Curlew, vessel, condemned and sold.....	10, 559
Federal Reserve Board, cooperation of Department.....	98, 219, 453, 455	diseases and parasites of fishes.....	489
reports, gold and silver, imports and exports.....	227	drying fresh fish.....	485
Federal Trade Commission, cooperation of Department.....	96, 98, 402, 455	estimates of appropriations, 1920.....	28
Fees, navigation, receipts.....	27, 147	exhibit, Southern Commercial Congress.....	688
Standards Bureau tests.....	434	fish and eggs, distribution.....	475, 478
Ferrin, A. W., investment-opportunity studies.....	197	shipments to Canada, Japan, Mexico, and Canal Zone.....	479
Field operations, Coast and Geodetic Survey.....	706	fish culture, experimental.....	498
		fish hatcheries.....	104, 476, 488, 558
		appropriations and expenditures.....	20
		Block Island, R. I.....	558
		San Marcos, Tex.....	476
		Woods Hole, Mass.....	485, 492, 494, 558

	Page.
Fisheries Bureau, Fish Hawk, vessel, service	
In Navy	104, 559
fish preservation, problems	496
fishskins, value for leather	107
food fishes, consumption	106
propagation	104, 474
supply, national security and defense fund	20
fresh-water mussels, artificial propagation	483
fur-bearing animals, minor, Alaska	112
protection	557
fur-seal skins, authenticating	555
fur seals	109, 110
Grampus, vessel, condemned and sold	10
Halcyon, vessel, service in Navy	10, 104
hearings, Seattle, Wash.	552
investigations, Fairport, Iowa	498
miscellaneous	492
laboratory-aquarium	13, 16
laboratory, fisheries products	108
Key West, Fla.	494, 558
national security and defense fund	13, 108
leather, aquatic sources	107, 508
legislation, proposed, status	559
motor boats operated	10
national security and defense fund, allotments and expenditures	13
personnel	17, 20, 33, 106, 112, 119, 473
Phalarope, Fisheries Bureau vessel, service	472, 557
In Navy	104, 559
preserved fish, bacteriology	485
products	484
Pribilof Islands	553
revenues	111
utilizing waste products of sealing industry	112
printing and binding cost	833
products laboratory	105
publications	553, 548
receipts, miscellaneous	27
rescuing food fish	20, 105
national security and defense fund	20
salaries, increases needed in lower grades	113
seal and salmon fisheries, Alaska, expenditures	20, 23, 25, 29
seal-oil plant, national security and defense fund	20
sealing industry, by-products plant, national security and defense fund	112
sealskins, classification	554
sales	554, 556
sources of supply, investigations	487
station, Bozeman, Mont	558
Cape Vincent, N. Y.	558
Orangeburg, S. C.	558
Woods Hole, Mass., use by Red Cross and Y. M. C. A.	104
stations transferred to Navy	471
stranded fishes rescued	490
subsistence allowance	831
tests by Standards Bureau	390
travel expenses	9
unexpended balances	9
vessels, Alaska	550
condemned and sold	10, 559
New England	504
operations	10, 104
Pribilof Islands	554
Roosevelt	554
transferred to Navy	10, 104, 471, 558
Fisheries-products laboratory, national security and defense fund, allotment	474
Fishery intelligence service, Alaska	551
Fishery patrol, Alaska	550
Fishery permits, Aleutian Islands	552
Fishery supervision, Minnesota Game and Fish Department	498
Wisconsin State Conservation Commission	498
Fishes, diseases and parasites	490
Fishing, commercial, Alaskan waters closed	548
Fishing vessels, census	444
Fishskins, value for leather	107
Five-Fathom Bank, N. J. fisheries	537
Flag, Service, Department's	39, 833
Flax production	170
Florida Reefs, Fla., aids to navigation	571, 601
Flounders fishery	527
Fog data, Lighthouse Service, compilation	573

	Page.
Fog signal, Cleveland Harbor, Ohio, completed	634
Fog signals. See Aids to navigation.	
Food Administration, cooperation of Department	52,
58, 85, 94, 95, 98, 106, 186, 208, 229, 230,	
252, 271, 349, 451, 455, 471, 473, 487	
Food fishes, consumption	106
distribution	474, 478
propagation	104, 474
rescuing	20, 105
national security and defense fund	20
Forbes Lithographic Co., cooperation of Department	331
Foreign and allied commissions, cooperation of Department	340
Foreign and Domestic Commerce Bureau, additional space needed	12
advertising methods, Latin America	198
after-war service	65, 173
appointments work	233
appropriations and expenditures	17
balance of trade	23, 24, 27, 28, 338, 240
bonds, Russian, returned by district offices	210
chemical imports, census	167
Chief Clerk's office, activities	237
Commerce Reports, publication	62, 222, 225
commercial agents at large, need for	211
commercial agents, need for	183
commercial and economic conditions, Scandinavia	199
commercial attachés, activities	52, 184
additional needs	15, 63, 63, 182
appropriations recommended	65, 183
changes in personnel	52, 176, 188
duties	176, 178
special work for other departments	179
war work	49, 52, 178
commercial map, China	188
cooperation, Agricultural Department	60, 221, 229
American Chemical Society	51, 167
Council of National Defense	53, 54, 219, 222, 229
Federal Reserve Board	219
Food Administration	52, 58, 186, 208, 229, 230
Fuel Administration	58, 208, 229
Interior Department	54, 62, 203
National Tanners' Council	58, 229
Navy Department	49, 53, 54, 202, 218, 242
Public Information Committee	218
Railroad Administration	53, 54, 206
Red Cross	218
Shipping Board	49
53, 54, 58, 60, 179, 204, 218, 220, 222, 229, 230, 242	
State Department	53, 54, 60, 179, 184, 202, 221
Tariff Commission	60, 228
Textile Alliance	58, 229
Treasury Department	227, 230
War Department	49
53, 54, 186, 187, 202, 203, 218, 219, 242	
War Industries Board	49
52, 53, 54, 58, 179, 203, 218, 229, 242	
War Minerals Committee	203
War Trade Board	49
52, 53, 54, 58, 60, 61, 179, 184, 185, 186, 202,	
203, 207, 208, 218, 220, 222, 229, 230, 231, 242	
cooperative offices, additional needs	211
developing trade by motion pictures	31
distribution section	239
district offices, activities	61, 62, 210
additional needs	64, 211
personnel	210
samples, exhibit	61
trade-mark information	60
trading-with-the-enemy act, activities	61
war work	61, 207
division of foreign tariffs	221
dystuffs, census of chemical imports	51
editorial division, activities	62, 234
estimates and appropriations, 1920	31
exhibit at Southern Commercial Congress	762
expansion of service	63
export classification, revision	230
export control, national security and defense fund	17
export licenses issued	207
export methods, studies	199
export trade, analyses	160, 162
exporters' index	233, 239
far-eastern division	60, 220

	Page.		Page.
Government Printing Office, cooperation of Department.....	253, 403, 865	Instrument makers, Coast and Geodetic Survey needs.....	678
Grampus, Fisheries Bureau vessel, condemned and sold.....	10, 559	Instruments and materials, standard tests.....	83
Grays Harbor, Wash., light station.....	630	"Integrating counter," tabulating device.....	102, 463,
Great Lakes, aids to navigation.....	573	Interior Department, cooperation of Commerce Department.....	54,
Great Salt Pond, R. I., light station.....	571, 600	62, 95, 98, 121, 203, 252, 259, 267,	
Greenhouses, commercial.....	95, 452	280, 315, 330, 331, 340, 351, 358, 375,	
Guam, aids to navigation.....	570	378, 393, 402, 407, 421, 424, 455, 552	
Guantanamo, aids to navigation.....	570	Internal-commerce statistics, collection, appropriation needed.....	64, 228
Guaranteed standards in industry.....	87	Internal Revenue Bureau, cooperation of Department.....	816
Gulfoast, aids to navigation.....	571, 602	International Aircraft Standards Board, cooperation of Department.....	83, 408, 409
Haddock fishery.....	526	International Customs Conference, Shanghai, Julean Arnold, commercial attaché of Department, chairman.....	53
Hake fishery.....	526	Investigations of foreign markets.....	54, 191
Halcyon, Fisheries Bureau vessel, service in Navy.....	10, 104, 559	Iris, lighthouse tender.....	581
Half holiday, Saturday, throughout year.....	39	Irrigation, Census Bureau inquiry.....	480
Halibut fishery.....	526	Iris, Coast and Geodetic Survey vessel, operations.....	644, 680, 685
Halsey, F. M., investment-opportunity studies.....	195	Italian Government, cooperation of Department.....	670, 695
Hardware, foreign markets.....	192	Japan, fish-eggs shipments to.....	479
Hardy Co., F. A., cooperation of Department.....	331	Japanese Government Railway Commission, tour.....	210
Hastings, Clifford, Chief of Appointment Division, annual report.....	823	Jessamine, lighthouse tender.....	581
Hatcheries operated, Fisheries Bureau.....	104,	Jewelry and silverware, foreign markets.....	196
476, 488, 558		Joe Flogger Shoal, Del., light and fog signal.....	600
Hawaii, aids to navigation.....	607, 628, 629	John Rodgers, lighthouse tender.....	581, 622
lighthouse depot, estimate.....	622	Johns Hopkins University, cooperation of Department.....	331
magnetic work.....	750	Joint Committee on Printing, cooperation of Department.....	402
Health index, weekly.....	447	Jones, Dr. E. Lester, Superintendent, Coast and Geodetic Survey, commissioned colonel.....	138, 680
Heat and thermometry division, Standards Bureau, activities.....	301	Jones, G. M., foreign-trade investigations.....	195, 203
Heat measurements, studies.....	80, 306	Jones Point Light Station.....	624
Heat treatment and thermal analysis.....	410	Jones, Tom O., foreign-trade investigations.....	193
Heather, lighthouse tender.....	581	Juniper Island Light Station.....	631
Henderson Point, Me., light station.....	629	Justice Department, cooperation of Commerce Department.....	98, 116, 117, 454, 552, 564
Heise, Dr. Bernhard C., chairman, American Chemical Society Committee, report.....	167	Karluk River, Alaska, closed to commercial fishing.....	548
Holly, lighthouse tender.....	581, 622	Kauahola Point, Hawaii, light station.....	629
Homs, Juan, foreign-trade investigations.....	191	Keepers of lighthouses, salaries.....	620
Honolulu, lighthouse depot.....	579	Kellett Bluff, Wash., light station.....	606
magnetic observatory.....	648, 705	Ketchikan, lighthouse depot.....	118
Hogulam, Wash., electrolysis survey.....	298	Keweenaw Waterway, Mich., aids to navigation.....	605
Housing Committee, cooperation of Department.....	98, 455	Key West, Fla., fisheries laboratory.....	494, 558
Huckleberry Island, Padilla Bay, Wash., lighthouse depot.....	573	lighthouse depot.....	571, 580
Hudson River, N. Y., aids to navigation.....	571, 600	Kilkenny, Navigation Bureau vessel.....	811, 813
shad fishery.....	538	Kukul, lighthouse tender.....	581
Hunts Point, N. Y., light and fog signal.....	571, 600	Labor Department, cooperation of Commerce Department.....	296, 340
Huron Harbor, Ohio, aids to navigation.....	604	Laboratories, Census Bureau, mechanical.....	101, 462
Hydrographer, Coast and Geodetic Survey vessel, operations.....	644,	Fisheries Bureau.....	13, 16, 168
685, 713, 715, 716, 717, 718, 732		national security and defense fund, allotment.....	13, 108
Hydrographic and geodetic engineers needed.....	684	Standards Bureau, industrial.....	84
Hydrography and topography division, Coast and Geodetic Survey.....	669, 684	low temperature.....	307
Hydrography, field work, Alaska.....	688	national security and defense fund, allotment.....	13, 19, 432
Atlantic coast.....	684, 706	Pittsburgh, tests.....	434
Pacific coast.....	688, 719	Lake Champlain, N. Y., aids to navigation.....	631
Philippine Islands.....	690	Lake Keokuk fisheries.....	543
summary.....	123	Lake Pepin fisheries.....	543
survey vessels needed.....	127	Lake Pokegama, Minn., mussel propagation.....	483
Illuminating Engineering Society, cooperation of Department.....	279, 327, 328, 329	Lake Tahoe, Cal. and Nev., aids to navigation.....	627
Import and export statistics, national security and defense fund.....	17	Larkspur, lighthouse tender.....	581
Import trade, analyses.....	150, 161	Latin America, advertising methods.....	198
Imports and exports, balance of trade.....	50	Investment opportunities.....	195, 197
gold.....	158	trade promotion.....	214
merchandise.....	150, 162	Latin American circulars.....	217, 239
Increase of compensation, appropriations and expenditures.....	17, 21, 22, 23	Latin American division, cooperation in war work.....	49, 218
Indian Service, Neah Bay, Wash., authenticating fur-seal skins.....	555	plans for future work.....	219
Indiana Harbor, Ind., aids to navigation.....	606	Lauches, wire-drag, additional needs.....	15, 130
Inductance and capacity, Standards Bureau work.....	273	Alaska.....	742, 743, 744, 745, 748
Industrial interests, cooperation of Department.....	331	Atlantic coast.....	708, 709, 710, 714, 715
Industrial Peace, Foundation for Promotion, fund returned.....	46	Laws, navigation and steamboat-inspection violations.....	779, 811, 814
Industrial standards, construction materials.....	62		
Information section, Standards Bureau.....	439		
Inks, Standards Bureau tests.....	349		
Inland waterways, national security and defense fund.....	17		
Inspections, vessels.....	785		
Inspectors on committees, Steamboat-Inspection Service.....	787		

	Page.		Page.
Laws and administration, weights and measures.	261	Lighthouse Service, jurisdiction.	585
Laws and regulations, fur-bearing animals, Alaska.	557	legislation, enacted affecting.	566, 682
Lease, Commerce Building.	12	needed.	564
Leases examined.	48	Liberty Loan, special work.	565
Leather, aquatic sources.	107, 503	subscriptions.	574
investigations.	338	life and property saved.	118, 564, 608
Standards Bureau tests.	348	national security and defense fund, allotment.	31, 118, 577, 580, 630
value of fishskins.	108	Navy Department's reimbursement of, expenditures.	579
Leaves of absence during year.	37, 38, 827	new works completed.	684
Legal opinions by Solicitor.	48	open-market purchases.	582
Legislation, mining, recommended.	263	personnel.	572, 573, 585
needed, Commerce and Navigation, fiscal to calendar year.	228	printing and binding cost.	615, 838
Fourteenth Census.	459	property damaged.	568
Lighthouse Service.	584	publications.	614
Official Register.	451	retirement, act of June 20, 1918.	621
parcel-post statistics.	64, 228	system.	38, 119, 563, 584, 621, 830
proposed, affecting Department, status.	46, 47, 559	saving of life and property.	118, 564, 608
recent, affecting Coast and Geodetic Survey.	137, 682	special works, construction.	599
affecting Lighthouse Service.	566, 682	substance allowance.	831
affecting Steamboat-Inspection Service.	143, 786	summary of costs.	575
Length, Standards Bureau studies.	255	tenders.	596, 598, 622, 631
Levy, Max, cooperation of Department.	331	tests by Standards Bureau.	407
Liberty engine.	314	vessels, construction.	117, 582, 598
Liberty Loan, Lighthouse Service aid.	565	damaged.	117, 614
subscriptions, Census Bureau.	453, 456	discontinued.	593
Lighthouse Service.	574	estimates.	621
Prbillof natives.	554	lost.	10, 119, 568, 582
summary.	45, 46	operations.	10, 117, 582, 594
Library, Department.	44	salaries and wages.	117, 583
Standards Bureau.	438	transferred to Navy.	115
Licenses, examined.	48	urgent needs.	119
officers of vessels.	140	War Department's reimbursement of, expenditures.	579
seamen, Steamboat-Inspection Service.	785	War Risk Insurance Bureau, decision.	573
Life and property saved, Lighthouses Bureau.	119, 564, 608	War-savings stamps, subscriptions.	574
Life preservers tested.	140, 775	war work.	564
Life-saving appliances, lives saved.	140	works authorized.	566
"Life tables," mortality conditions.	100, 457	Lighthouse tenders.	570, 573, 581
Light keepers' dwellings, estimate.	622	descriptive list.	596
Light, optical instruments, and sound division, Standards Bureau.	315	transferred to Navy.	563
Light Station, Navassa Island, West Indies, completed.	633	Lighthouses Bureau, aids to navigation, appropriations and expenditures.	21, 22, 26
Light vessel No. 45, damage and fire.	582	Caribbean Sea, national security and defense fund.	31, 630
Light vessels, construction and repair.	117, 582, 598	improvement of apparatus and equipment.	115, 120, 571
descriptive list.	594	Navassa Island, West Indies, light station established.	115, 563, 565, 599, 633
details as to lights.	588	number.	114
discontinued.	593	appropriations and expenditures.	17,
number in service.	582, 583	21, 22, 26, 27, 29, 566, 569, 577, 598, 615	
status.	583	appropriations for special works.	118, 119, 120, 578
Lighthouse Service, administration methods and economies.	573	Cedar, vessel, placed in commission.	50
aids to navigation.	563,	Commissioner, Department's representative, New York Harbor Wage Adjustment Board.	117
allotment, national security and defense fund.	31, 118, 577, 580, 630	construction work.	118
appropriations.	566, 569, 570, 577, 615	Cross Rip Light Vessel No. 6, Mass., lost.	10,
construction of tenders and vessels.	598		119, 582
special works.	577, 599	depot, third lighthouse district, national security and defense fund.	31
unexpended balances.	607	Diamond Shoal Light Vessel No. 71, N. C., sunk.	10, 119
construction and repair work.	599, 637	exhibit, Southern Commercial Congress.	762
cooperation, Coast and Geodetic Survey.	565	increased work due to war.	116
Fisheries Bureau.	565	inspections.	118
Justice Department.	117, 564	Ketchikan, depot.	118
Navy Department.	115, 117, 563	Navassa Island, West Indies, light station established.	115, 563, 565, 599, 633
New York Harbor Wage Adjustment Board of Arbitration.	564	personnel.	38, 114, 117, 119, 572, 573, 585, 830
Shipping Board.	564	Portsmouth, Va., depot.	583
Treasury Department.	564	printing and binding cost.	831
War Department.	115, 117, 563	publications.	851
War Industries Board.	117, 564	receipts, miscellaneous.	27
cost-keeping system and results.	574	salaries, increases.	117, 119
damage by collisions.	614	officers and crews of vessels.	117, 119
depots.	571, 573, 579, 586, 599, 622	sale of publications, legislative authority.	119
district, limits.	586	Staten Island, naval base.	116
superintendents.	585	stations transferred to Navy.	115
employees in Army and Navy.	573	storm damage to property.	118
engineering and construction.	570	summary of work.	114
estimates for 1920.	30, 577, 617	"superintendent of lighthouses," designation changed from "lighthouse inspector".	119
special works.	578, 618, 621	Tompkinsville, N. Y., depot.	118
Executive orders affecting.	573		
expenditures.	570, 577, 598, 616		
fog data, compilation.	573		
Great Lakes, aids to navigation.	573		

	Page.
Lighthouses Bureau, travel allowance and subsistence, teachers of lighthouse keepers' children.....	119
unexpended balances.....	29
vessels.....	10, 115, 117, 119
Lights. <i>See</i> Aids to navigation.	
Lime, gypsum, etc., studies.....	428
Linen industry, American.....	169
Little Konulji Island, Alaska, fur farm.....	558
Lives lost, accidents, vessels.....	10, 119, 140, 146, 780
vessels subject to inspection.....	779
Lives saved by appliances.....	780
Load-line regulations.....	816
Lorain Harbor, Ohio, aids to navigation.....	571, 604
Los Angeles, chamber of commerce petition, Anacapa Island, Cal., light and fog signal.....	628
electrolysis survey.....	298
Louisville, Ky., natural-gas investigation.....	288
Low-temperature laboratory.....	307
Lubricants, tests.....	387
Ludington, Mich., aids to navigation.....	626
Lumber, foreign markets.....	196
Lundquist, R. A., foreign-trade investigations.....	192, 200
McKeon, T. F., Chief, Publications Division, annual report.....	837
Mackerel fishery.....	526
Madison, Wis., electrical-resistance tests.....	299
Magnetic measurements, Standards Bureau.....	275
Magnetic observations, Coast and Geodetic Survey.....	127, 648, 704
Magnetic observatories.....	127, 648, 671, 705, 738
Magnetic work, Alaska.....	741
Hawaii.....	750
Philippine Islands.....	750
Porto Rico.....	749
United States.....	738
Virgin Islands.....	749
Magnolia, lighthouse tender.....	581
Mail and files section, Standards Bureau.....	438
Mailing lists, Department's.....	43, 861
Mangrove, lighthouse tender.....	581
Manila, Coast and Geodetic Survey exhibit.....	662
Manitowoc, Wis., aids to navigation.....	606, 631
Manufactures, reports.....	90, 443
Maple, lighthouse tender.....	581
Mare Island, Cal., light station discontinued.....	567
Marigold, lighthouse tender.....	581
Marinduque, Coast and Geodetic Survey vessel, operation.....	644, 691, 750, 756, 760
Marine-boiler plates tested.....	775
Marine services, Department's.....	10
Marion, Ohio, electrolysis survey.....	298
Marmot Island, Alaska, fur farm.....	558
Marriage and divorce, statistics.....	99, 456
Masonry Supreme Council, cooperation of Department.....	331
Mass, Standards Bureau studies.....	258
Massachusetts Committee on Public Safety, cooperation of Department.....	811
Massachusetts Institute of Technology, cooperation of Department.....	371
Massachusetts State Highway Commission, Standards Bureau tests.....	375
Massachusetts weights and measures department, cooperation of Commerce Department.....	271
Master gauges, munitions, standardization.....	71
Matchless, Coast and Geodetic Survey vessel, operations.....	644, 685, 712, 713
Materials, advertisement of proposals.....	43
in explosives, census.....	452
miscellaneous, measurements and investigations.....	84
Mayflower, lighthouse tender.....	581
Measurement standards.....	247
Mechanical appliances, Standards Bureau studies.....	356
Mechanical laboratory, Census Bureau.....	101, 462
Meetings and conventions, travel expenses.....	9
Mellon Institute, Pittsburgh, cooperation of Department.....	424
Menhaden, increasing consumption.....	497
Merchandise, imports and exports.....	156, 162
Merchant marine, American, 1917 and 1918.....	793
United States, tonnage.....	145, 792
Merchant vessels completed, United Kingdom, 1917-18.....	798

	Page.
Metallurgical chemistry.....	343, 417
Metallurgical tests, fees.....	407
Metallurgical work, national security and defense fund.....	19, 432
Standards Bureau.....	81
Metallurgy division, Standards Bureau.....	404
Metals and alloys, research work.....	81, 411
Metals, Standards Bureau studies.....	350, 363, 408
Metric system, literature.....	87
War Department use.....	87
Mexico, fish shipments to.....	479
Michigan Island, Wis., light station.....	627
Middleton Island, Alaska, fur farm.....	558
Military services. <i>See</i> Army.	
Milwaukee, Wis., electrolysis survey.....	298
lighthouse depot.....	580
Mineral resources, foreign markets.....	198
Minerals and Derivatives, Joint Information Board, cooperation of Department.....	98, 455
Mining legislation recommended by Department.....	263
Minnesota Game and Fish Department, fishery supervision.....	498
Minnesota Railroad and Warehouse Commission, cooperation of Department.....	267
Miscellaneous receipts.....	27
Mississippi River, aids to navigation.....	571, 602
Mississippi River Commission, cooperation of Department.....	688
Mistletoe, lighthouse tender.....	581, 622
"Monthly Summary of Foreign Commerce," publication.....	226
Motion pictures, appropriation needed for developing trade.....	31
promoting commerce.....	173, 187
Motor Boat Show, Coast and Geodetic Survey exhibit.....	688, 711, 763
Motor boats, cooperation, collecting internal-revenue taxes.....	149
Fisheries Bureau, operations.....	10
undocumented, numbering.....	149
Motor vehicles, Department's.....	43
foreign markets.....	193
Municipal institutions and committees, cooperation of Department.....	340
Municipalities, Standards Bureau relation.....	287
Munitions, gauges tested.....	72
master gauges, standardization.....	71
Murre, Fisheries Bureau vessel.....	550
Mussels, propagation.....	483
Nantucket Shoals, Mass., light station.....	598
National Advisory Committee for Aeronautics, cooperation of Department.....	68, 69
122, 252, 314, 330, 335, 339, 362, 363, 364, 371, 397, 408, 411	
National Association of Master Plumbers, cooperation of Department.....	289
National Brick Manufacturers' Association, cooperation of Department.....	360, 422
National Commercial Gas Association, cooperation of Department.....	289
National Council of Cotton Manufacturers, cooperation of Department.....	399
National District Heating Association, cooperation of Department.....	292
National Electric Light Association, cooperation of Department.....	291
National Electrical Safety Code.....	79
National Fire Protection Association, cooperation of Department.....	289
National Hollow Tile Manufacturers' Association, cooperation of Department.....	423
National Motor Boat Show, exhibit.....	688, 711, 763
National Museum, cooperation of Department.....	407
National Optical Glass Co., cooperation of Department.....	427
National Physical Laboratory, cooperation of Department.....	413
National Research Council, cooperation of Department.....	329, 330, 345, 408, 421, 424
National Safety Council, cooperation of Department.....	289
National Scale Men's Association, cooperation of Department.....	262
National security and defense fund, allotments and expenditures, Census Bureau Coast and Geodetic Survey.....	13, 17, 23, 34
Customs Statistics Bureau.....	230

	Page.		Page.
National security and defense fund, allotments and expenditures, Fisheries Bureau.....	13, 17, 20, 33, 108, 112, 119, 473	Navigation fees and fines.....	27, 147
Foreign and Domestic Commerce Bureau.....	17, 23, 31, 230, 231, 238	Navigation laws, enforcement.....	148, 811
Lighthouse Service.....	31, 118, 577, 580, 630	expenditures.....	19, 24, 28
Navigation Bureau.....	82	violations.....	811, 814
Roberts's by-product coke oven.....	19, 432	Navy, Census Bureau employees.....	99, 455
Secretary's Office.....	17	Coast and Geodetic Survey employees.....	121
Standards Bureau.....	13, 17, 19, 24, 33, 431, 432	123, 133, 663, 664, 680	
National Tanners' Council, cooperation of Department.....	348, 388	former employees.....	20, 533
National Terra Cotta Society, cooperation of Department.....	423	Lighthouse Service employees.....	572
Natural Gas Association of America, cooperation of Department.....	289	Navigation Bureau employees.....	147, 800, 817
Naval services. See Navy.		Navy Department, Coast and Geodetic Survey employees commissioned.....	121, 123, 680
Naval Torpedo Station, cooperation of Department.....	283	Coast and Geodetic Survey officers transferred.....	663, 664
Navassa Island, West Indies, light station established.....	115, 563, 565, 599, 633	Coast and Geodetic Survey vessels transferred.....	123, 644, 680, 684, 685
Navigation aids, Alaska.....	114	cooperation of Commerce Department.....	49
569, 571, 606, 625, 628, 635		53, 54, 104, 115, 116, 117, 121, 123, 141, 202, 218,	
Guantanamo, Samoa, and Guam.....	570	242, 252, 253, 258, 259, 267, 283, 284, 290, 300,	
improvements and construction.....	568	301, 314, 315, 329, 330, 331, 332, 333, 340, 342,	
increases and changes.....	567	345, 346, 347, 349, 353, 354, 357, 359, 362, 365,	
Virgin Islands.....	570, 623	366, 370, 373, 375, 379, 380, 382, 383, 385, 387,	
Navigation Bureau, admeasurement of vessels.....	149	389, 402, 406, 407, 409, 412, 417, 424, 440, 471,	
allotment notes.....	808	563, 676, 682, 684, 695, 708, 711, 712, 750, 764,	
appropriations and expenditures.....	17, 19, 20, 24, 25, 27, 28	786.	
changes in trade since 1914.....	791	Fisheries Bureau, stations transferred.....	471
cooperation, Internal Revenue Bureau.....	816	vessels transferred.....	10, 104, 471, 558
Massachusetts Public Safety Committee.....	811	lighthouse stations transferred.....	115
counting of passengers.....	815	lighthouse tenders transferred.....	563
employees in Army and Navy.....	817	Mare Island Light Station, Cal., transferred.....	567
enforcement of navigation laws.....	811	patrol, protecting fur seals and sea otters.....	554
estimate of appropriations, 1920.....	32	reimbursement of Lighthouse Service expenditures.....	579
merchant marine, American, 1917 and 1918.....	146, 793	Negroes, report.....	94, 450
merchant tonnage, United States.....	145, 792	Netherlands Government, Standards Bureau ratings.....	358
merchant vessels built in United States, 1916-1918.....	796	Netherlands ships requisitioned.....	806
motor boats, cooperation, collecting internal-revenue taxes.....	149	Neutral tonnage losses.....	806
numbering of undocumented.....	149	Nevada, aids to navigation.....	626
national security and defense fund, allotment.....	32	New Boston, Ill., mussel propagation.....	483
navigation laws, enforcement.....	148	New England vessel fisheries.....	504
expenditures.....	19, 24, 28	New Jersey Board of Public-Utility Commissioners, cooperation of Department.....	288
new vessel, national security and defense fund.....	32	New Orleans, La., electrolysis survey.....	298
overcrowding vessels, prevention.....	148, 814	lighthouse depot.....	580, 624
expenditures.....	19, 25, 28	radio school.....	811
passenger act of 1882.....	816	New York Butter Packing Co., cooperation of Department.....	331
penalties for violations, navigation laws.....	813	New York Central Railroad, cooperation of Department.....	286
personnel, military services.....	147, 809, 817	New York customhouse, foreign-samples exhibit.....	212
printing and binding cost.....	838	New York Harbor Wage Adjustment Board of Arbitration, Commissioner of Lighthouses representing Department.....	117
publications.....	852	cooperation of Department.....	98
radio communication.....	147, 280, 809	New York, N. Y., branch gauge laboratory established.....	72
radio operators, licenses issued.....	810	foreign samples, exhibit.....	212
radio schools.....	811	New Zealand customs authorities, cooperation of Department.....	408
Radio Service, printing and binding cost.....	838	Newport, R. I., lighthouse depot.....	630
receipts from duties, fees, and fines.....	27, 147, 807	Nine Mile Point, Mich., light station.....	630
receipts, miscellaneous.....	27	Nitric acid, census.....	453
seamen, desertions.....	808	Norfolk, Va., radio school.....	811
nationality.....	809	Oak, lighthouse tender, bids.....	588
shipped and discharged.....	807	Observatories, Cheltenham, Md.....	127, 648, 705, 738
wages.....	808	Honolulu, Hawaii.....	127, 648, 706
shipbuilding, American, progress.....	795	magnetic.....	127, 648, 671, 706, 738
steel, 1900-1917.....	805	San Antonio, Tex.....	671
wooden.....	804	Sitka, Alaska.....	127, 648, 705, 748
shipping commissioners.....	147, 807	Tucson, Ariz.....	127, 648, 705, 739, 740
shipping losses.....	805	Vieques, P. R.....	127, 643, 705
tonnage duties.....	807	Occupations of registrants, classification.....	96, 454
tonnage losses, British, allied, and neutral.....	806	Odeff, Ralph M., foreign-trade investigations.....	182
unexpended balances.....	28	Office division, Standards Bureau.....	421
vessels, admeasurement and load line.....	149, 816	Office room, Census Bureau.....	465
analysis of year's construction.....	794, 800, 803	Officers and crews, subsistence allowance.....	881
bulk.....	794, 800, 803	Officers licensed.....	778
gains and losses during war.....	792	Official Register of United States, discontinued.....	46, 451
Kilkenny operations.....	813	prepared and published.....	94, 451
seagoing, 1,000 gross tons or over.....	794	Oils, Standards Bureau tests.....	349
wireless, clearances and inspections.....	810	Omaha, Nebr., electrolysis survey.....	298
war service.....	817	Open-market purchases, Lighthouse Service.....	584
wireless communication laws, enforcement expenditures.....	19, 24, 25, 28	Operators, radio, licenses issued.....	810

	Page.
Opinions rendered by Solicitor.....	48
Optical glass, production, national security and defense fund.....	19, 432
studies.....	426
Optical instruments and light, studies.....	72, 332
Orangeburg, S. C., fishery station.....	558
Oregon, aids to navigation.....	571, 606
Oregon waters, additional surveys needed.....	650
Osprey, Fisheries Bureau vessel.....	550
Overcrowding of vessels, prevention.....	148, 814
expenditures.....	19, 25, 28
Oxholm, A. H., foreign-trade investigations.....	197, 203
Pacific coast, hydrographic and topographic work.....	688, 719
wire-drag operations.....	125, 127, 647
Pacific Fisheries Association, salmon-tax activity.....	548
Pacific Steamship Co., vessels stranded.....	650
Paint, Standards Bureau studies.....	354
Pan American trade-mark bureau.....	169, 223
Panama Canal Commission, cooperation of Department.....	252, 253, 283, 340, 351, 366, 375, 385, 390, 394, 407
Paper, paper products, and printing machinery, foreign markets.....	193
Paper, Standards Bureau studies.....	348, 399
Parcel post, foreign statistics, legislation needed.....	64, 228
negotiations with Chile.....	223
Passenger act of 1892.....	816
Passengers, carried on vessels.....	140, 782, 816
overcrowding steamers, prevention.....	815
Paste, Standards Bureau tests.....	349
Pathfinder, Coast and Geodetic Survey vessel, operations.....	644, 690, 691, 750, 751, 753, 754, 755
Patterson (temporarily renamed U. S. S. Forward), Coast and Geodetic Survey vessel, operations.....	644, 693, 690, 688, 690, 720, 745, 746
Peace, Foundation for Promotion of Industrial, fund returned.....	46
Pearl Harbor, Hawaii, aids to navigation.....	607
Pearl Island, Alaska, fur farm.....	558
Pearson, H. C., foreign-trade investigations.....	194, 203
Penalties for violations, navigation laws.....	813
Pennsylvania Railroad, cooperation of Department.....	256, 331
Pennsylvania Wire Glass Co., cooperation of Department.....	831
Pensioners' ages, Census Bureau searches.....	100, 458
Performance standards.....	249
Personnel, appointments during year.....	825
appointments through United States Employment Service.....	832
assistant to Secretary of Commerce, position needed.....	16
bonded employees.....	829
Census Bureau.....	102, 464
changes during year.....	35, 824
civil-service methods.....	832
Coast and Geodetic Survey.....	16, 121, 131, 132, 133, 134, 135, 667, 674, 680
commercial attachés.....	15, 52, 176, 188
clerks.....	15
insufficient appropriations.....	65
data compiled.....	829
deferred classifications.....	39, 833
district offices.....	64, 210
employees, by bureaus and services.....	24, 35
draft age.....	39, 833
in Army and Navy.....	39, 99, 121, 123, 138, 147, 455, 573, 663, 664, 690, 809, 817, 833
examinations for special registers.....	832
Fisheries Bureau.....	472, 557
Foreign and Domestic Commerce Bureau.....	242
hydrographic and geodetic engineers, additional.....	132
leaves of absence during year.....	37, 38, 427
Lighthouses Bureau.....	38, 114, 117, 119, 572, 573, 585, 830
war-risk insurance, employees transferred to military services.....	117
military draft, no exemptions claimed.....	39
military services. <i>See</i> Army.	

	Page.
Personnel, promotion of employees, Department's policy.....	36, 825
reductions of employees.....	325
reinstatement eligibility of former employees.....	833
retirement of superannuated.....	38, 119, 135, 530
salaries, average.....	39, 831
Census Bureau.....	102
Coast and Geodetic Survey.....	133, 134, 135
entrance, inadequate.....	37, 39, 102, 135, 831
Fisheries Bureau.....	113
increase of \$120 granted.....	38, 831
Lighthouses Bureau.....	117, 119, 621
need for increases.....	37, 39, 65, 102, 113, 135, 831
Solicitor's Office.....	48
Steamboat-Inspection Service.....	143, 787
seamen, enlistments and wages.....	130, 131
separations of employees.....	825
Standards Bureau.....	435
statistics.....	823
Steamboat-Inspection Service.....	51, 139, 143, 799, 787
superannuation.....	38, 119, 135, 830
temporary appointments.....	832
temporary transfers to War and Navy Departments.....	34, 115, 123
transfers from other departments.....	36
travel allowance.....	9, 119
war situation, effect.....	833
women, appointment.....	39, 833
Phalarope, Fisheries Bureau vessel, service in Navy.....	104, 559
Philippine Government, vessels, loaned to Coast and Geodetic Survey.....	10, 123, 645, 691
returned by Coast and Geodetic Survey.....	645, 691
Philippine Islands, hydrographic and topographic work.....	690
magnetic work.....	750
Photometry and illuminating engineering.....	277
Physical chemistry.....	341
Physical constants defined.....	248
Pittsburgh laboratory, Standards Bureau tests.....	434
Pittsburgh Plate Glass Co., cooperation of Department.....	427
Platinum, Colombian, foreign markets.....	214
Russian shipment, transferred to Committee on Raw Materials.....	172
Standards Bureau studies.....	347
supply.....	171
Point Borinquen, P. R., light station.....	604
Point Pinos, Cal., light station.....	627
Point Vicente, Cal., aids to navigation.....	606
Polarimetry, studies.....	319
Pollock fishery.....	526
Port Eads, La., lighthouse depot.....	624
Port Facilities Commission, cooperation of Department.....	98, 455
Port Real, P. R., or East Point Vieques Island, light station.....	629
Portage Lake, Mich., aids to navigation.....	629
Portland Cement Association, cooperation of Department.....	378
Portland, Me., fisheries.....	504
Porto Rico, magnetic work, Coast and Geodetic Survey.....	749
Ports and transportation facilities, China.....	198
Ports, transportation facilities, and export packing, South America.....	195
Portsmouth, Va., lighthouse depot.....	120, 580, 622
Post Office Department, cooperation of Commerce Department.....	252, 253, 256, 270, 300, 340, 371, 394, 407, 444, 557
Potomac River, aids to navigation.....	120, 624
Potter, Emma F., schooner. <i>See</i> Emma F. Potter.	
Potters' Association, cooperation of Department.....	423, 424
Power derrick barge for Hudson River.....	598
Practice standards defined.....	260
Precise levels, run and needed.....	125, 648, 699
Pribilof Islands, fur-seal reports.....	553
Liberty Loan subscriptions.....	554
National security and defense fund, allotment.....	473
revenues.....	111
sealing industry, utilizing waste products.....	112

	Page.
Printing and binding, advertisement of proposals.....	43, 862
allotment and expenditures.....	17, 27, 39, 40, 837, 838, 864
cost, by bureaus.....	537
estimates, appropriations for 1920.....	29, 34, 563
mailing lists.....	43, 861
quantity and cost.....	39, 539
stationery, etc., distribution.....	41
summary of work.....	41, 539
<i>See also</i> Publications; Publications Division.	
Prisoners and juvenile delinquents, report.....	94, 451
Prisons and Prison Labor, National Committee, cooperation of Department.....	98, 455
Promoting commerce, Central and South America, expenditures.....	17, 23, 24, 28
Promotion of employees, Department's policy.....	36, 825
Promotion of Industrial Peace, Foundation for, fund returned.....	46
Property and stores, Standards Bureau.....	437
Property, Lighthouse Service, damaged, saved by Lighthouse service.....	118, 808
Proposals for supplies.....	45
Prosecutions, fishery violations, Alaska.....	550
Public Information Committee, cooperation of Department.....	218
Public Safety, Massachusetts Committee on, cooperation of Department.....	811
Public-Service Commission, First District, New York, cooperation of Department.....	288
Indiana, cooperation of Department.....	288, 292
Oregon, cooperation of Department.....	288
Public-service commissions, cooperation of Department.....	287
Public utilities, research work and testing.....	78, 286
Publications, Census Bureau.....	450, 461, 843
Coast and Geodetic Survey.....	671, 681, 694, 695, 844
distribution.....	43, 858
estimates.....	863
expenditures.....	838, 864
Fisheries Bureau.....	553, 846
Foreign and Domestic Commerce Bureau.....	51, 55, 56, 57, 59, 62, 63, 173, 175, 191, 192, 193, 194, 196, 197, 217, 222, 228, 234, 240, 848
issued, list.....	41, 42, 840
Lighthouse Service.....	614, 851
Navigation Bureau.....	852
sales.....	27, 42, 119, 859
Secretary's Office.....	841
Standards Bureau.....	255, 258, 262, 270, 276, 278, 280, 281, 284, 288, 290, 291, 292, 293, 295, 299, 302, 304, 306, 312, 316, 319, 334, 335, 337, 340, 373, 378, 388, 405, 424, 436, 852
Steamboat-Inspection Service.....	856
Publications Division, advertising.....	43, 862
allotment and expenditures.....	17, 39, 40, 837
distribution of publications.....	43, 858
duplicating work.....	861
duties.....	837
editorial work.....	861
mailing lists.....	43, 861
publications issued.....	41, 42, 840
sales of publications.....	27, 42, 119, 859
Puget Sound, Wash., aids to navigation.....	571, 606
fisheries.....	528
Purchase Section, Standards Bureau.....	438
Putnam, George R., Commissioner, Lighthouses Bureau, annual report.....	563
Pyrometry studies.....	303
Quality standards defined.....	248
Radio communication.....	147, 280, 809
Radio laboratory.....	14
Radio operators, licenses issued.....	810
Radio schools.....	811
Radio Service, printing and binding cost.....	838
Radio work.....	14
Radioactivity and X-ray measurements.....	283
Radiometry.....	335
Railroad Administration, cooperation of Department.....	53, 54, 208, 252, 265, 354, 375
development of internal waterways.....	47
operation of Cape Cod and the Delaware and Raritan Canals.....	47
Railroad and Warehouse Commission, Minnesota, cooperation of Department.....	
Railroad Commission, Georgia, cooperation of Department.....	
Railroad Wage Commission, cooperation of Department.....	
Railway equipment, material, and supplies, foreign markets.....	
Railway Signal Association, cooperation of Department.....	
Ram Island, Me., light.....	
Receipts, miscellaneous.....	
sales, charts, and publications, Coast and Geodetic Survey.....	
publications of Department.....	27, 42
tonnage duties, fees, and fines.....	
Reclamation Service, Denver and San Francisco, transfer to Standards Bureau.....	
Reconstruction, tariff policies.....	
Red Cross, cooperation of Department.....	104
use of Fisheries Bureau station, Woburn, Mass.....	
Red salmon, Alaskan census.....	
Reductions of employees.....	
Refractories Manufacturers' Association, cooperation of Department.....	
Register, Official, of United States. <i>See</i> Official Register.....	
Registrants, ages, transcripts.....	
estimates.....	
occupations, classification.....	
Regulations, fur-bearing animals, protection, Supervising Inspectors Board.....	
Reinstatement eligibility, former employees.....	
Religious bodies, report.....	
Rent, estimates of appropriations, 1920, paid by Department.....	
Representatives, Department's, meetings and conventions, travel expenses.....	
Research, Coast and Geodetic Survey vessel, operations.....	644, 691, 757
Research division, Foreign and Domestic Commerce Bureau.....	
Research work, Department's library.....	
Resistance standards, electrical.....	
Retirement, Coast and Geodetic Survey employees.....	135, 66
Lighthouse Service, act of June 20, 1918, employees.....	38, 119, 563, 584, 62
Rhea, Frank, foreign-trade investigations.....	19
River herring, increasing consumption.....	
Roberts's by-product coke oven, national security and defense fund.....	15
Rogers, Sam. L., Director, Census Bureau, annual report.....	
Romblon, Coast and Geodetic Survey vessel, operations.....	644, 691, 756, 757, 758
Roosevelt, Fisheries Bureau vessel.....	554
Rosenthal, Samuel W., foreign-trade investigations.....	
Rubber, foreign markets.....	
Standards Bureau studies.....	348
Russia and Germany, tariff publication.....	
Russian bonds returned.....	
Sabine Bank, Tex., light station.....	
Sabine Pass, La., light station.....	
Sag Harbor, N. Y., aids to navigation.....	
St. Johns River, Fla., aids to navigation.....	571
St. Joseph, Mich., lighthouse depot, transferred to Navy.....	
St. Marys River, Mich., aids to navigation.....	
St. Nicholas, vessel, rescued by Fisheries Bureau.....	
St. Paul, Minn., electrolysis survey.....	
Salaries, average, employees.....	39
Census Bureau.....	
Coast and Geodetic Survey.....	133, 134
entrance, inadequate.....	37, 39, 102
Fisheries Bureau.....	
Increase of \$120 granted.....	
Lighthouses Bureau.....	117, 118
need for increases.....	37, 39, 65, 102, 133, 143
Solicitor's Office.....	
Steamboat-Inspection Service.....	148
Sales, charts and publications, Coast and Geodetic Survey.....	27, 42

	Page.		Page.
Sales, condemned property of Department...	45	Simeonof Island, Alaska, fur farm.....	558
miscellaneous.....	27, 45	Simmons, Roger E., foreign-trade investiga-	
publications, Department's.....	27, 42, 119, 859	tions.....	197, 203
Lighthouses Bureau, legislative authority.....	119	Sitka, Alaska, magnetic observatory.....	648, 705, 748
Salmon and seal fisheries, Alaska.....	20, 23, 25, 29	Smith, H. M., Commissioner, Fisheries Bu-	
Salmon canned in Alaska, tax.....	547	reau, annual report.....	471
Solicitor's opinion.....	548	Smith, Philip S., foreign-trade investiga-	
Salmon canneries, Yukon River, Alaska.....	552	tions.....	192, 205
Salmon hatcheries, private, inspection.....	548	Smithsonian Institution, cooperation of De-	
Samoa, aids to navigation.....	570	partment.....	375, 407
San Antonio, Tex., observatory.....	671	Snowdrop, lighthouse tender.....	581
San Francisco, Cal., Reclamation Service,		Soap, Standards Bureau studies.....	354
transferred to Standards Bureau.....	373	Society for Constructive Endeavor, Peking..	181
San Francisco Chamber of Commerce, peti-		Soldiers' needs, cooperation of Department..	86
tion for light and fog signal, Anacapa		Solicitor, opinion, Alaska tax on salmon	
Island, Cal.....	628	canned.....	548
San Marcos, Tex., fish hatchery reopened.....	476	attorneys, small salaries.....	48
Sand Hills, Mich., light station.....	571, 605	summary of work.....	47, 48
Sand Island, Oahu, Hawaii, lighthouse depot.	573	Sound and acoustics, studies.....	76, 281, 338
Sandy Hook Proving Ground, cooperation of		South America, markets, electrical goods....	192
Department.....	275	South and Central America, expenditures in	
Sanger, J. W., foreign-trade investigations....	198	promoting commerce.....	17, 23, 24, 28
Santa Barbara, Cal., light station.....	628	Southern Commercial Congress, exhibit,	
Santa Fe Railway, cooperation of Depart-		Coast and Geodetic Survey.....	688, 711, 762
ment.....	331	Lighthouse Service.....	578
Saturday half holiday throughout year.....	39	Southern Railway, cooperation of Depart-	
Saving of life and property, Lighthouse		ment.....	256
Service.....	118, 564, 608	Special agents, practical value.....	204
Scales, commercial, Standards Bureau tests	263	war work.....	202
mine and railroad-track.....	75	Special registers, examinations.....	832
Scandinavia, commercial and economic con-		Special works, Lighthouse Service.....	599, 618, 621
ditions.....	199	Spectroscopy, Standards Bureau studies.....	315
Schools, radio.....	811	Springfield, Mass., electrolysis survey.....	286
Scientific interests, cooperation of Depart-		Springfield Railway Co., cooperation of De-	
ment.....	331	partment.....	298
Seal and salmon fisheries, Alaska.....	20, 23, 25, 29	Standard samples, Standards Bureau.....	355
Seal, fox, and other skins, sales receipts.....	27	Standardization, munitions master gauges..	71
Seal herd, Alaska, census.....	556	timepieces.....	76
Seal killings, Fribolof Islands.....	555	Standards Bureau, acoustics and sound,	
Seal-oil plant, national security and defense		studies.....	76, 281, 338
fund.....	20	aeronautical research.....	68, 359, 361
Sealskins, classification.....	554	aid given Cleveland, Ohio.....	288
sales.....	554, 556	airplane dopes.....	349
Seamen, certificates issued and rejected.....	140	airplane-engine laboratory.....	14
deserion.....	808	airplane materials.....	363
enlistments and wages.....	130, 131, 659, 808	airplane power plants.....	70, 312
nationality.....	809	airplanes, studies.....	68, 69, 70
shipped and discharged.....	807	Allegheny County, Md., scales tests and	
Seattle, Wash., fisheries.....	527	testimony.....	263
hearings.....	552	allotment by Government departments.....	432
Secretary's Office, appropriations and ex-		alloys and metals, research work.....	61, 411
pensitures.....	17, 24, 27	altimeters, tests.....	69
estimates of appropriations, 1920.....	30	analytical methods and standard samples....	355
national security and defense fund, allot-		appropriations and expenditures.....	17,
ment.....	17	18, 19, 24, 27, 28, 298, 355, 431, 432	
printing and binding cost.....	838	bituminous materials.....	352
publications.....	941	brass investigations.....	414
receipts, miscellaneous.....	27	building, national security and defense	
unexpended balances.....	27	fund.....	13, 19
Separations of employees.....	825	power plant.....	16
Service Flag, Department's.....	39, 833	radio laboratory.....	14
Seventh lighthouse district depot.....	625	buildings occupied.....	11
Shad fishery, Hudson River.....	538	capacity and density.....	260
Sharks, increasing consumption.....	496	cement, tests.....	83, 350, 372
Shipbuilding, American progress.....	795	for Massachusetts.....	375
census.....	90, 444	ceramics division, activities.....	422
Shipping Board contracts.....	805	chemical reagents and apparatus.....	347
wooden.....	804	chemistry division, activities.....	340
Shipping Board, compensation to Nether-		chemistry tests.....	85
lands shipowners.....	806	clay products.....	422
cooperation of Department.....	49,	colorimetry.....	325
53, 54, 58, 80, 94, 95, 98, 117, 142, 179, 204, 218,		commercial scales.....	263
220, 222, 229, 230, 242, 252, 260, 314, 330, 333		concrete studies.....	372, 378
342, 351, 353, 354, 371, 374, 375, 376, 380, 384		conferences.....	262, 267, 342
385, 402, 451, 455, 471, 564, 785, 787		cooperation, Agricultural Department.....	252,
588		256, 285, 331, 340, 378	
pay schedules, officers and crew.....	805	Aluminum Company of America.....	411, 412
shipbuilding contracts.....	799	American Association of Refrigeration.....	306
ships built, fiscal year 1918.....	145, 146	American Ceramic Society.....	423
vessels owned.....	583	American Chemical Society.....	347
wage scale, deck and engine departments.....	147, 807	American Gas Institute.....	289
Shipping commissioners.....	805	American Institute of Architects.....	289
Shipping losses.....	805	American Lithographic Co.....	331
Shipping Service, Navigation Bureau, print-		American Railway Association.....	256
ing and binding cost.....	838	American Society for Testing Materials.....	374,
Ships, Netherlands, requisitioned.....	806	352, 353, 359, 364, 409, 410, 417, 423	
Shoes and leather, foreign markets.....	193	American Society of Civil Engineers.....	370
Shut-offs, passenger vessel.....	814		

	Page.
Standards Bureau, cooperation, American Society of Mechanical Engineers	262, 366
American Society of Refrigerating Engineers	306
American Writing Paper Co.	331
Artificial Daylighting Co.	331
Assay Office, New York	348
Associated Factory Mutual Fire Insurance Companies	300
Association of Edison Illuminating Companies	201
Association of State Geologists	424
Australian and New Zealand customs authorities	408
British Imperial Munitions Board	417
Cooper Hewitt Electric Co.	328, 331
Corning Glass Works	331
Council of National Defense	402
Customs Service	253, 324, 325
Dorsey, Vernon M.	331
Du Pont De Nemours Co., E. I.	331
Elmer & Amend	331
Emergency Fleet Corporation	314, 352, 371, 376, 380, 384, 408, 414, 421
Employees' Compensation Commission	205
General Trade Commission	402
Fisheries Bureau	504
Food Administration	252, 271, 349
Forbes Lithographic Co.	331
Foreign and allied commissions	240
Forest Products Laboratory	209
French War Ministry	417
Fuel Administration	262, 288, 423
General Supply Committee	253, 340, 388, 390, 402
Goodyear Tire & Rubber Co.	345
Government Printing Office	253, 403
Hardy Co., F. A.	331
Illuminating Engineering Society	279, 327, 328, 329
Indiana Public-Service Commission	283, 292
Interior Department	252, 256, 267, 290, 315, 330, 331, 340, 351, 358, 375, 378, 393, 421, 424
International Aircraft Standards Board	408, 409
Johns Hopkins University	331
Joint Committee on Printing	402
Labor Department	296, 340
Levy, Max	331
Massachusetts Institute of Technology	371
Massachusetts State Highway Commission	375
Mellon Institute, Pittsburgh	424
National Advisory Committee for Aeronautics	69, 252, 314, 330, 335, 339, 362, 363, 364, 371, 397, 408, 411
National Association of Master Plumbers	289
National Board of Fire Underwriters	309
National Brick Manufacturers' Association	369, 422
National Commercial Gas Association	259
National Council of Cotton Manufacturers	399
National District Heating Association	262
National Electric Light Association	291
National Fire Protection Association	289
National Hollow Tile Manufacturers' Association	423
National Museum	407
National Optical Glass Co.	427
National Physical Laboratory	413
National Research Council	329, 330, 345, 408, 421, 424
National Safety Council	289
National Scale Men's Association	262
National Tanners' Association	348, 388
National Terra Cotta Society	423
Natural Gas Association of America	289
Naval Torpedo Station	283
Navy Department	252, 253, 258, 259, 267, 283, 284, 290, 300, 301, 314, 315, 329, 330, 331, 332, 333, 340, 342, 345, 346, 347, 349, 353, 354, 357, 359, 362, 365, 366, 370, 373, 375, 379, 380, 382, 383, 385, 387, 389, 402, 406, 407, 409, 412, 417, 424, 440
New Jersey Board of Public-Utility Commissioners	283
New York Butter Packing Co.	331
New York Central Railroad	256
New York Dyestuff Convention	329

	Page.
Standards Bureau, cooperation, Oregon Public-Service Commission	258
Panama Canal Commission	252, 253, 283, 340, 351, 366, 375, 385, 390, 394
Pennsylvania Railroad	256, 331
Pennsylvania Wire Glass Co.	331
Pittsburgh Plate Glass Co.	427
Portland Cement Association	378
Post Office Department	252, 253, 256, 270, 300, 340, 371, 384
Public-Service Commission, First District, New York	288
public-service commissions	257
Railroad Administration	252, 265, 354, 375
Railroad and Warehouse Commission, Minnesota	267
Railroad Commission, Georgia	258
Railway Signal Association	277
Red Cross	284
Refractories Manufacturers' Association	423, 424
Sandy Hook Proving Ground	275
Santa Fe Railway	331
scientific, commercial, and industrial interests	331
Shipping Board	252, 260, 314, 330, 333, 342, 351, 353, 354, 371, 374, 375, 376, 380, 384, 402
Smithsonian Institution	375
Society of Cotton Products Analysts	329
soldiers' needs	86
Southern Railway	256
Springfield Railway Co.	296
State highway commissions	375
State, municipal, and other institutions and committees	340
States	262
Supreme Council of Masonry	331
Tariff Commission	312, 331
Treasury Department	252, 253, 259, 303, 340, 366, 375, 395, 402
United States Pottery Association	423, 424
United States Rubber Co.	345
Vacuum Oil Co.	274
Virginia Shipbuilding Corporation	267
War Department	85, 252, 253, 255, 256, 258, 259, 267, 268, 269, 271, 274, 275, 276, 277, 278, 280, 283, 284, 290, 302, 307, 308, 312, 313, 320, 329, 330, 332, 333, 340, 342, 345, 347, 349, 350, 351, 352, 353, 354, 355, 357, 359, 362, 365, 368, 371, 373, 375, 385, 389, 390, 391, 392, 393, 394, 395, 397, 398, 401, 406, 409, 410, 414, 417, 440
War Industries Board	398, 402, 408, 415, 421
Williams, Brown & Earle	231
Worcester Polytechnic Institute	371
copying section	439
dispatch section	439
dispensoids	335
dyes, tests	349
electric light and power service, studies	78, 291
electrical research and testing	77, 273, 292
electricity division, activities	272
electrochemistry	282, 341
electrolysis prevention, studies	296, 298
engineering instruments, studies	358
engineering research and testing division, activities	356
estimates of appropriations	21, 22, 32
experiments, aeroplane fabric	169
hemp-fibers	170
fabrics, production, national security and defense fund	19, 432
fire-extinguisher investigations	356
fire-resistive properties, structural materials	306
foundry investigations	421
functions	67, 247
gas chemistry	344
gas engineering	296
gas-measuring instruments	261
gas service, studies	78
gauges	266
glass, optical	426
glue and paste, tests	349
guaranteed standards in industry	87
heat and thermometry division, activities	301

	Page.
Standards Bureau, heat measurements.....	80, 306
heat treatment and thermal analysis.....	410
heating service, studies.....	78
inductance and capacity.....	273
industrial laboratory, national security and defense fund.....	432
information section.....	439
inks, tests.....	349
instruments and materials, tests.....	83
"International Aircraft Standards," specifications.....	83
laboratories.....	14, 84, 307, 434
national security and defense fund.....	19
leather.....	348, 388
length, studies.....	255
Liberty engine.....	314
library.....	438
light, optical instruments, and sound division, activities.....	315
lime, gypsum, etc.....	428
location.....	254
lubricants.....	387
magnetic measurements.....	275
mail and files section.....	438
mass.....	268
materials, miscellaneous, measurements and investigations.....	84
measurement standards.....	247
mechanical appliances.....	356
metallurgical chemistry.....	343, 417
metallurgical work.....	81
national security and defense fund.....	19, 432
metallurgy, studies.....	404
test fees.....	407
metals and alloys, research work.....	81, 350, 368, 411
metals, microscopy.....	409
metric system.....	87
mining legislation recommended.....	263
munitions master gauges, standardization.....	71
National Electrical Safety Code.....	292
National Gas Safety Code.....	299
national security and defense fund, allotment.....	13, 17, 19, 24, 33, 431, 432
natural gas, investigations.....	288
new building, national security and defense fund, allotment.....	432
office division, duties.....	431
oils, tests.....	349
optical glass, production, national security and defense fund.....	19, 432
optical instruments.....	72, 332
organization.....	253
paint and varnish.....	354
paper.....	309
performance standards.....	249
personnel.....	435
photometry and illuminating engineering.....	377
physical chemistry.....	341
physical constants defined.....	348
Pittsburgh laboratory, tests.....	434
platinum, studies.....	347
polarimetry.....	319
power-plant building.....	16
practice standards.....	260
printing and binding cost.....	338
property and stores section.....	437
public utilities, research work and testing standards.....	78
publications.....	255, 258, 262, 270, 276, 278, 280, 281, 284, 288, 290, 291, 292, 293, 295, 296, 302, 304, 306, 312, 316, 319, 334, 335, 337, 340, 373, 378, 388, 405, 424, 436, 452
purchase section.....	438
pyrometry.....	308
quality standards.....	248
radio communication.....	14, 280
radioactivity and X-ray measurements.....	263
radio-laboratory building.....	14
radiometry.....	335
ratings for Netherlands Government.....	358
receipts, miscellaneous.....	27
Reclamation Service, Denver and San Francisco, transfer.....	373
relation to Government service.....	252
relation to municipalities.....	287
relation to public.....	250

	Page.
Standards Bureau, relation to State commissions.....	287
resistance standards.....	273
Roberts's by-product coke oven, national security and defense fund.....	19, 432
rubber.....	348, 360
scales, mine and railroad-track, investigation.....	75
scope of work.....	67
soldiers' needs, cooperation.....	86
sound and acoustics, studies.....	76, 281, 338
spectroscopy.....	315
standards in density.....	87
stone, tests.....	372, 383
street-railway service, studies.....	78
structural, miscellaneous, and engineering division, activities.....	363
stucco and plaster.....	377
sugar, studies.....	85, 320, 322, 324, 325
telephone service, studies.....	78, 299
Washington, D. C.....	300
temperature and heat investigations.....	80
tests, District of Columbia.....	253, 304, 407
fees.....	434
Fisheries Bureau.....	390
Lighthouse Service.....	407
Massachusetts State Highway Commission.....	375
Steamboat-Inspection Service.....	366, 407
summary.....	433
textiles, tests.....	340, 396
thermite investigation, national security and defense fund.....	19, 432
thermometry.....	301
time measurement.....	359
timepieces, tests.....	76, 290
tin, conservation.....	415
unexpended balances.....	26
war situation, effect on personnel.....	538
weights and measures, conference.....	262
division, activities.....	265
laws and administration.....	261
Standards in density.....	87
Star of Chile, vessel, rescued by Fisheries Bureau.....	559
State commissions, Standards Bureau relation.....	287
State conferences, Standards Bureau.....	263
State Department, cooperation of Commerce Department.....	53, 54, 60, 179, 184, 202, 221
State fishery authorities, cooperation of Department.....	473
State highway commissions, cooperation of Department.....	375
State institutions and committees, cooperation of Department.....	340
State institutions, statistical directory.....	100, 458
Staten Island, N. Y., lighthouse depot.....	116, 571,
	600, 623, 628
States, financial statistics.....	98, 449
Stationery supplies, distribution.....	44
Statistics division, Foreign and Domestic Commerce Bureau.....	58, 226
Steamboat-Inspection Service, accidents on vessels.....	140, 780
alleged disloyalty, investigations.....	786
appropriations and expenditures.....	17, 19,
	25, 27, 28, 770
business methods.....	783
casualties and violations of law.....	779, 814
certificates, service and efficiency, issued and rejected.....	140, 777
color blindness, examinations.....	777
cooperation, Coast and Geodetic Survey.....	719
Navy Department.....	141, 786
Shipping Board.....	785, 787
efficiency of service.....	143, 788
estimates of appropriations, 1920.....	82
exhibit, Southern Commercial Congress.....	763
fire-extinguisher investigations.....	356
inspections, miscellaneous.....	774
inspectors on committees.....	787
interned enemy vessels.....	142
legislation, recent.....	143, 786
licenses issued.....	140, 776, 785
life preservers tested.....	140, 775
life-saving appliances, lives saved.....	140

	Page.		Page.
Steamboat-Inspection Service, lives lost and saved.....	140, 779, 780	Thrift and war-savings stamps, purchases.....	45,
marine-boiler plates tested.....	775	Tidal observations.....	46, 454
office work, summary.....	770	Tide tables, charts, coast pilots, and inside route pilots, sales.....	125, 647
organization.....	139, 769	preparation and production.....	42
passengers carried on vessels.....	140, 782	Tides and currents section, hydrography and topography division, Coast and Geodetic Survey.....	694
personnel.....	15, 139, 142, 769, 787	Time measurement, Standards Bureau studies.....	259
printing and binding cost.....	838	Timepieces, tests.....	76
publications.....	856	Tin, conservation.....	415
receipts, miscellaneous.....	27	imports.....	172
regulations, Supervising Inspectors Board.....	784	Tobacco, leaf, statistics.....	98, 450
reinspections.....	774	Toledo Harbor, Ohio, aids to navigation.....	570,
salaries, increases.....	143, 787	Tompkinsville, N. Y., lighthouse depot.....	580
steel plates for marine-boiler construction, inspected.....	140	national security and defense fund.....	115, 580
summary of activities.....	139	Tonnage, American merchant marine.....	145, 146, 792
tests by Standards Bureau.....	366, 407	foreign trade.....	195
traveling inspectors, summary of work.....	782	receipts from duties.....	27, 147, 807
unexpended balances.....	26	Topographic maps needed.....	697
vessels, boilers, engines, and machinery, designs approved.....	140	Topographic work, Alaska.....	647, 698
inspected and certificated.....	139, 771, 785	Atlantic coast.....	647, 694, 706
war work.....	783	Pacific coast.....	698, 719
Steorage passengers carried.....	816	Philippine Islands.....	648, 690
Stock and shipping section, summary of work.....	44	Topography division, Coast and Geodetic Survey.....	699, 694
Stone, tests.....	373, 383	Trade, after-war.....	173
Storage space, Census Bureau.....	465	Trade commissioners, cooperation in war work.....	53, 58
Strachan, W. A., foreign-trade investigations.....	199	duties.....	211
Stratton, S. W., Director, Standards Bureau, annual report.....	247	resident, needed in foreign countries.....	63, 189, 211
Structural, miscellaneous, and engineering materials division, Standards Bureau.....	363	summary of work.....	53, 189
Stucco and plaster, investigations.....	377	Trade difficulties, adjustment.....	180, 185
Subsistence allowance, officers and crews.....	831	Trade-informal division, Foreign and Domestic Commerce Bureau.....	231
Sugar, Standards Bureau studies.....	85,	Trade investigations.....	191
	820, 822, 824,	Trade-marks, bureau, Pan American.....	169, 223
Sumac, lighthouse tender.....	581	foreign piracy.....	53, 169, 221, 222
Sumflower, lighthouse tender.....	581	priority, information furnished.....	30
Superannuation and retirement, Coast and Geodetic Survey.....	135, 661, 678	Trade opportunities, results.....	309
Lighthouse Service.....	38, 119, 568, 584, 621, 630	Trade promotion, industrial standards for construction materials.....	62
Superintendent of Documents, cooperation of Department.....	859, 861	Trading with the enemy, service.....	234, 339
Superintendents, lighthouse districts.....	585	Transportation by water, report.....	90, 444
Supervising Inspectors Board, regulations.....	784	Travel allowance.....	9, 119
Supplies Division, summary of work.....	45	Traveling inspectors, Steamboat-Inspection Service.....	783
Supplies, expenditures and proposals.....	45	Treasury Department, cooperation of Commerce Department.....	96, 116, 227, 230, 252, 263, 269, 308, 340, 368, 375, 395, 402, 407, 455, 489, 564
Surveyor, Coast and Geodetic Survey vessel, operations.....	644, 680, 685	Treaty, Brest-Litovsk, analysis.....	223
Swan, Fisheries Bureau vessel.....	550	Triangulation, work of Coast and Geodetic Survey.....	127, 648
Swordfish fishery.....	527	Tropical products, production and export.....	199
		Tucker, W. A., foreign-trade investigations.....	194
Tacoma, wrecked vessel, rescues.....	559	Tucson, Ariz., magnetic observatory.....	705, 739, 740
Tahoma, revenue cutter, lost.....	662	Typewriter purchases.....	45
Taku, Coast and Geodetic Survey vessel, condemned and sold.....	123, 683, 689, 747		
operations.....	644, 689, 746	Uhler, Geo., Supervising Inspector General, Steamboat-Inspection Service, annual report.....	769
Tampa Bay, Fla., aids to navigation.....	626	Unexpended balances.....	27
Tanners' Council, cooperation of Department.....	58,	United Kingdom, merchant vessels completed, 1917 and 1918.....	798
	98, 220, 456	United States Rubber Co., cooperation of department.....	345
Tariff between Germany and Russia, publication.....	222		
Tariff Commission, cooperation of Department.....	59, 60, 228, 312, 331	Vacuum Oil Co., cooperation of department.....	274
Tariffs, division of foreign.....	221	Varnish, Standards Bureau studies.....	354
Tarragon, Navigation Bureau vessel.....	811	Vessels, accidents.....	10, 119, 140, 780
Tax, salmon canned in Alaska.....	547	admeasurement.....	149, 816
Telephone service, standards.....	299	Alaska fishery.....	550, 554
study, Washington, D. C.....	300	Albatross, service in Navy.....	104
Temperature and heat, studies.....	80	American merchant, 1917 and 1918.....	783
Temporary appointments.....	832	analysis of year's construction area surveyed, Pacific coast and Alaska.....	793
Tenders, Lighthouse Service.....	598, 621	Blue Wing, condemned and sold.....	10
Terrestrial magnetism division, Coast and Geodetic Survey.....	671, 704	built, 1917 and 1918.....	794, 800
Tests, spruce buoys, Vineyard Sound, Mass.....	571	built by Shipping Board.....	789
Standards Bureau fees.....	439, 434	built for foreign owners.....	146
Textile Alliance, cooperation of Department.....	58, 229	Cedar, placed in commission.....	10
Textiles, foreign markets.....	194		
Standards Bureau studies.....	349, 395		
Thermite in vestigation, national security and defense fund.....	19, 432		
Thermometry studies.....	501		
Third lighthouse district, estimates.....	621, 624		
Thread substitute, Standards Bureau experiments.....	170		

	Page.		Page.
Vessels, Coast and Geodetic Survey, and given		Virgin Islands, West Indies, aids to navigation	570, 623
schooner Emma F. Potter	709	census	99, 457
condemned and sold	123, 683	magnetic work	749
loaned by Philippine Government	10, 128, 645	Virginia Shipbuilding Corporation, cooperation of Department	267
operations	10	Vital statistics, report	91, 446
15, 123, 124, 127, 129, 644, 646, 684, 689, 711, 712	123	Vocational Education Board, cooperation of Department	62
returned to Philippine Government	645, 691	foreign-trade education	175
transferred to Navy	123, 644, 680, 684, 685	Wage Adjustment Board of Arbitration, New York Harbor, cooperation of Department	455, 564
urgent needs	15, 134, 649	Wage Commission, Railroad, cooperation of Department	98, 455
commercial, placed under Army and Navy	145	Wages, railroad employees, data	98
condemned and sold	10, 123, 589, 683	seamen	131, 808
construction	117	Walker, J. R., foreign-trade investigations	196, 205
Curlew, condemned and sold	10	War Department, Coast and Geodetic Survey employees commissioned	680
damaged by fire	117	War Department, cooperation of Commerce Department	49
destroyed by Germany	146	53, 54, 85, 94, 96, 97, 98, 115, 116, 117, 121, 186, 187, 202, 203, 218, 219, 242, 252, 253, 255, 256, 258, 259, 267, 268, 269, 271, 274, 275, 276, 277, 278, 280, 283, 284, 290, 302, 307, 308, 312, 313, 320, 329, 330, 332, 333, 340, 342, 345, 347, 349, 350, 351, 352, 353, 354, 355, 357, 359, 362, 365, 368, 371, 373, 374, 375, 385, 389, 390, 391, 392, 393, 394, 395, 397, 398, 401, 406, 409, 410, 414, 417, 440, 446, 451, 453, 454, 455, 471, 563, 676, 682, 696, 700, 701, 703, 718	
enforcement of navigation laws	148	reimbursement of Lighthouse expenditures	579
Fish Hawk, service in Navy	104, 559	War Industries Board, cooperation of Department	49
Fisheries Bureau, condemned and sold	10, 159	52, 53, 54, 58, 82, 94, 95, 96, 98, 117, 179, 208, 218, 220, 242, 275, 374, 398, 402, 407, 408, 415, 423, 451, 452, 455, 564	
operations	10, 104	War materials and commodities, census	451
Fribill Islands	554	War Minerals Committee, cooperation of Department	208
transferred to Navy	10, 104, 471, 558	War-risk insurance, decision, affecting Lighthouse Service	117, 573
fisheries, New England	504	War-savings and thrift stamps, purchases	45, 46, 456, 574
Seattle, Wash.	527	War situation, effect on personnel	833
foreign trade, tonnage	165	War Trade Board, cooperation of Department	49
gains and losses during war	792	52, 53, 54, 58, 60, 61, 94, 95, 179, 184, 185, 186, 202, 203, 207, 208, 218, 220, 222, 229, 280, 281, 242, 451, 471	
Government construction	146	War, vessels during gains and losses	792
Grampus, condemned and sold	10, 559	War work, Census Bureau	446, 451, 455
Halcyon, service in Navy	10, 104, 559	Coast and Geodetic Survey	121, 680
inspections	139, 140, 771, 785	commercial attachés	49, 52, 178
interned enemy	142	Foreign and Domestic Commerce Bureau	61
life preservers tested	140, 775	178, 202, 207, 218, 283	
Lighthouse Service, construction	117, 582, 598	Latin American division	218
damaged	117, 614	Lighthouse Service	554
discontinued	593	Navigation Bureau	817
estimates	621	special agents	202
lost	10, 119, 568, 582	Steamboat-Inspection Service	793
operations	10, 117, 582, 594	Washington, aids to navigation	571, 606
salaries and wages	117, 583	Washington-Alaska Military Cable and Telegraph System, cooperation of Department	551
transferred to Navy	115	Washington, D. C., telephone service, Standards Bureau study	79, 300
urgent needs	119	Washington waters, surveys needed	650
lives lost, accidents	10, 119, 140, 146, 790	Water, transportation by	90, 444
loaned by Philippine Government	10, 123, 645, 691	Waters, Alaskan, closed to commercial fishing	548
lost	10, 119, 568, 582	Waterways, development	47
merchant, American tonnage	145, 792, 793	Weights and measures, laws and administration	261
built in United States, 1916-1918	796	Standards Bureau division, activities	255
motor boats, cooperation, collecting internal-revenue taxes	149	Whales and porpoises, increasing consumption	469
numbering of undocumented	149	Wharves, estimate for improvement	580
Navigation Bureau, expenditures	19, 24, 28	White Shoal, Mich., light station	571, 605
Kilkenny operations	813	Whitman, Paul P., foreign-trade investigations	198, 200
national security and defense fund, allotment	32	Williams, Brown & Earle, cooperation of Department	331
operations	10	Williams, Charles S., foreign-trade investigations	192
New England fishery	504	Williams, J. H., foreign-exchange investigations	219
overcrowding, prevention	148, 814	Wire-drag launches, needed	15, 130
owned by Shipping Board	145, 146		
Phalarope, service in Navy	104, 559		
radio apparatus	14, 147, 280, 809		
Roosevelt, Fisheries Bureau	554, 559		
seagoing, 1,000 gross tons or over	794		
steel, building in United States, 1900-1917	905		
steel plates for boiler construction inspected	140		
stranded	650		
surveys, needs for	127, 131		
Taku, condemned and sold	123, 683, 689, 747		
tonnage, American	145, 146, 792		
tonnage losses, British, allied, and neutral	906		
transferred to Navy, Coast and Geodetic Survey	10, 121, 123, 644, 680, 684, 685		
Fisheries Bureau	10, 104, 471, 558		
Lighthouse Service	10, 115		
Navigation Bureau	10		
types built during year	803		
United Kingdom merchant, completed 1917 and 1918	798		
wire-drag launches	15		
130, 708, 709, 710, 714, 715, 742, 743, 744, 745, 748	810		
wireless, clearances and inspections	559		
wrecked, rescues from	559		
Vessels and equipment section, hydrography and topography division, Coast and Geodetic Survey	693		
Vieques, P. R., magnetic observatory	648, 705		
Vineyard Sound, Mass., testing spruce buoys	571		
Violations, navigation and steamboat-inspection laws	779, 811, 814		

	Page.		Page.
Wire-drag launches, operations, Alaska	125	Woods Hole, Mass., use of Fisheries Bureau station by Red Cross and Y. M. C. A. .	104
Atlantic coast	127, 130, 646, 658, 741	Worcester Polytechnic Institute, cooperation of Department	371
Pacific coast	121, 125, 130, 646, 647, 658, 706		
surveys completed and needed	125, 127, 647		
Wireless communication	127, 130, 656		
Wireless communication	147		
laws, enforcement, expenditures	10, 24, 25, 26	Y. M. C. A., cooperation of Department	104, 811
Wisconsin State Conservation Commission, fishery supervision	496	Detroit, radio school	811
Women, appointments in Department	39, 823	use of Fisheries Bureau station, Woods Hole, Mass.	104
Wood River, Alaska, red-salmon census	551	York River Ship Building Corporation, cooperation of Department	712
Woodbine, lighthouse tender	581		
Woods Hole, Mass., aids to navigation	570	Yukon, Coast and Geodetic Survey vessels, operations	644, 689, 748
fish-cultural work	435, 492, 494, 558	Yukon River, Alaska, salmon canneries	583
lighthouse depot	569		





